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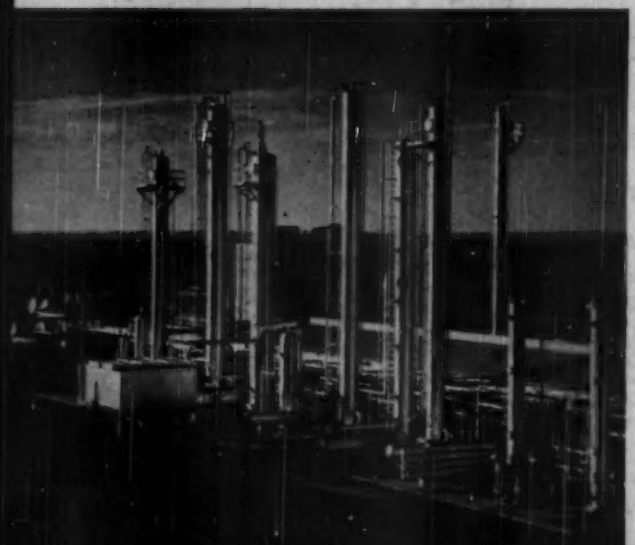
TOP *in any Season*

WHEN YOU USE

WARREN'S *Stabilized*

NATURAL GASOLINE OR STA-VOL-ENE

For **INCREASED VAPOR PRESSURE**



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What if it is freezing cold—your exposed steam traps won't cause you any worry if they're Yarway.

Yarway Impulse Steam Traps don't freeze because condensate does not accumulate. The only moving part—a little valve—is continually testing for condensate and passing it as soon as it forms. It never waits for a trapful to collect. Hence, there's never anything to freeze.

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PETROLEUM REFINER

Specialized for Refining, Natural Gasoline and Petrochemical Engineering, Operation and Management

R. L. DUDLEY, President — A. L. BURNS, General Manager

VOLUME 29, No. 12 — DECEMBER, 1950

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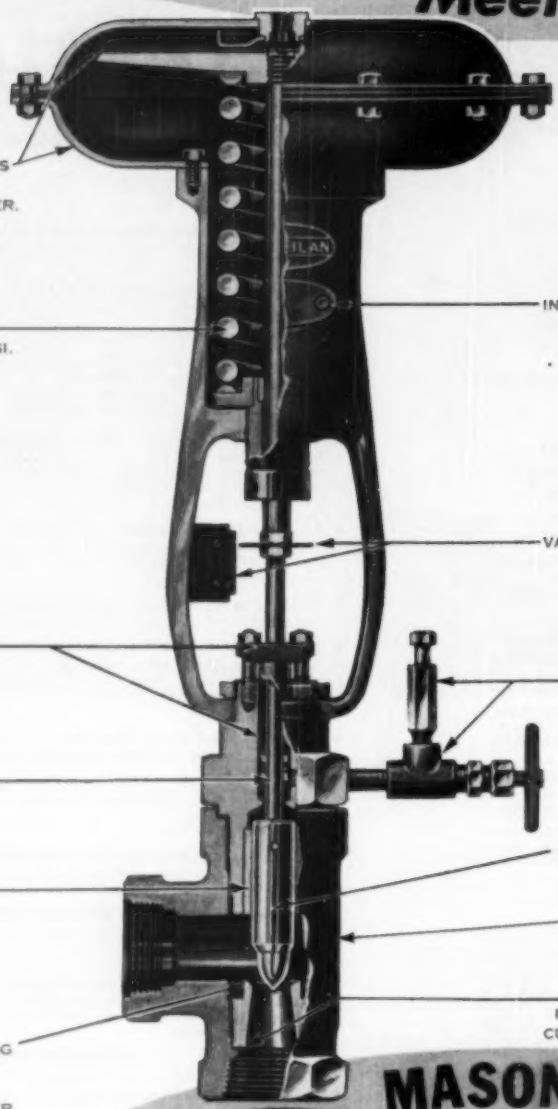
MASONEILAN HIGH
Meet Severe



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Action — Direct action (air-to-close) is standard. Reverse action (air-to-open) available.

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Diaphragm — neoprene or rubber.

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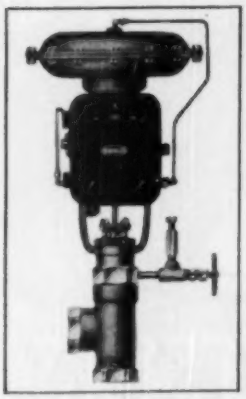
¼" pressure lubricator with forged steel isolating valve.

AIR-FIN BONNET

Available — not standard.

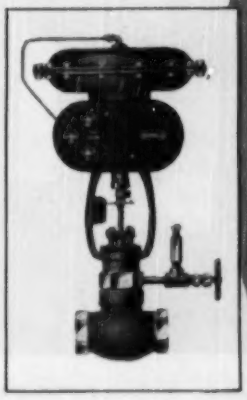
SPRING RANGES

3–15 psi standard.
6–30 psi available.



No. 717V
with No. 2707
Pressure Controller

No. 137-5
Control Valve



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Has high degree of surface stability under oxidizing conditions up to 1200° F. Excellent oxidation resistance and good corrosion resistance. For use in cracking furnaces, heat exchangers, hot oil lines, superheaters, and for forgings and other parts exposed to oxidation or oil corrosion.

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DM-2	2¼% Cr.-1% Mo.	Sicromo 7	25-12*
Silmo	Sicromo 3	Sicromo 9M	35-15*
DM	4-6% Cr.-Mo.	18-8 Stainless	16-25-6*
2% Cr.-Mo.	4-6% Cr.-Mo.-Ti.	18-8 Cb	

**Available as seamless tubing on an experimental basis only.*

Many high temperature steels will solve your heat, pressure, corrosion and oxidation problems. But only *one* will give you maximum tube life per dollar—the best life over cost ratio.

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To get the "most tube for your dollar" *ask the experts!* Write The Timken Roller Bearing Company, Canton 6, Ohio. Cable address: "TIMROSCO".

Timken was the first company to test high temperature steels, starting in 1928. Stress-rupture test (see below) was invented by metallurgists at Timken.

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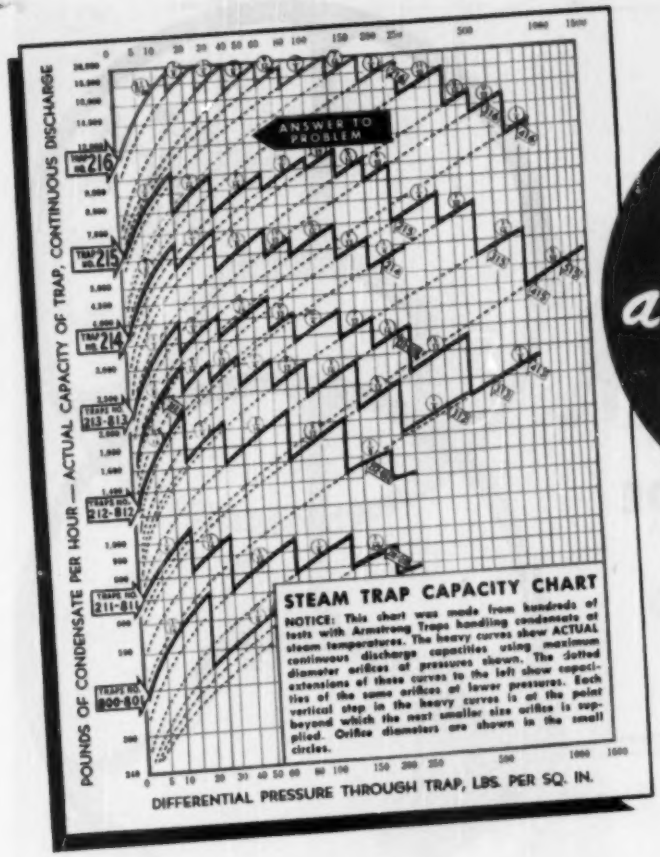
ANSWER TO PROBLEM
TRAP NO. 216
TRAP NO. 215
TRAP NO. 214
TRAPS NOS. 213-813
TRAPS NOS. 212-812
TRAPS NOS. 211-811
TRAPS NOS. 200-801
POUNDS OF CONDENSATE PER HOUR — ACTUAL CAPACITY OF TRAP, CONTINUOUS DISCHARGE
DIFFERENTIAL PRESSURE THROUGH TRAP, LBS. PER SQ. IN.
STEAM TRAP CAPACITY CHART
NOTICE: This chart was made from hundreds of tests with Armstrong Traps handling condensate at steam temperatures. The heavy curves show ACTUAL continuous discharge capacities using maximum diameter orifices at pressures shown. The dotted extensions of these curves to the left show capacities of the same orifices at lower pressures. Each vertical step in the heavy curves is at the point beyond which the next smaller size orifice is supplied. Orifice diameters are shown in the small circles.

BECAUSE good trapping starts with selection of the right trap for the job, Armstrong has provided all the data necessary for correct trap selection in the Armstrong Steam Trap Book. The Capacity Chart reproduced here is taken from this handy reference work. By means of this chart, any engineer can select the correct traps for his requirements. Here is a typical problem showing how the chart is used:

Given: An evaporator condensing 6000 lbs/hr at 50 psi when the steam is first turned on, but condensing only 1000 lbs/hr at 150 psi at the end of the process. Safety factor of 2 to 1 required at the ***minimum*** pressure differential.

Solution: Referring to the chart, the No. 216 Armstrong Trap with 7/16" orifice for 150 psi pressure has a capacity of 12,000 lbs/hr at 50 psi. This provides for the 2 to 1 safety factor and is, therefore, the correct trap for the job.

The Armstrong Steam Trap Book provides recommended safety factors for different services and handy tables to help you calculate condensing rates. Other useful data included are: hook-up diagrams; do's and don't's; trouble-shooting tips; prices and specifications. You're welcome to a copy. **ARMSTRONG MACHINE WORKS, 852 Maple Street, Three Rivers, Michigan.**

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For fuel savings, low maintenance, automatic air removal SPECIFY ARMSTRONG!

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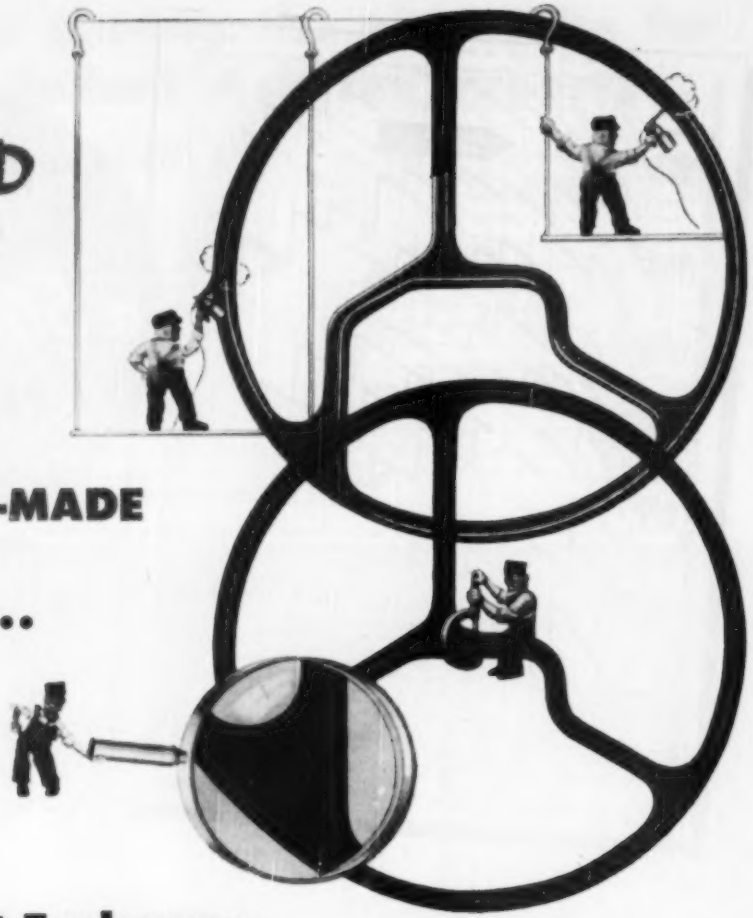

PRECISION-MADE
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...this Heat Exchanger Gasket will stay on the job longer

The durable coating of red paint on every Goetze iron or steel-jacketed Style 923 Heat Exchanger Gasket is a sure "stop light" against rust. And rust, as every metal gasket user knows, is a primary cause of deterioration—both in the storehouse and on the job awaiting installation.

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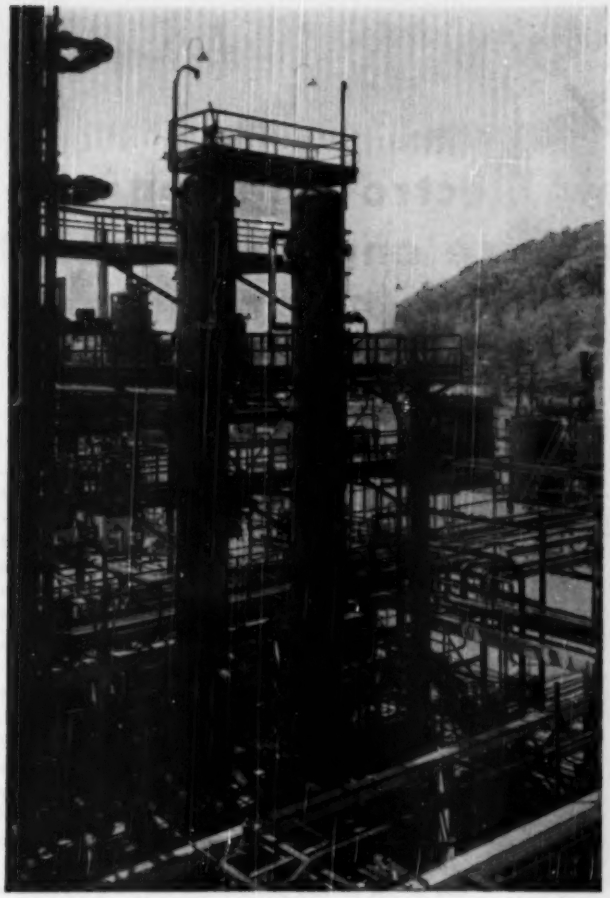

Uses

Girbotol plant

to purify <u>both</u>

Liquid and

Gaseous

hydrocarbons

THIS NEW REFINERY gets double duty from its Girdler Girbotol Plant. Using a common reactivator, the Girbotol Plant removes hydrogen sulphide from both liquid and gaseous hydrocarbons.

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The Girbotol process has proved to be the most economical method known for separating hydrogen sulphide from liquid hydrocarbons such as butane, propane, poly-feed stocks, straight-run naphthas and gasolines; and from natural, refinery and other gases.

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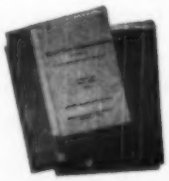

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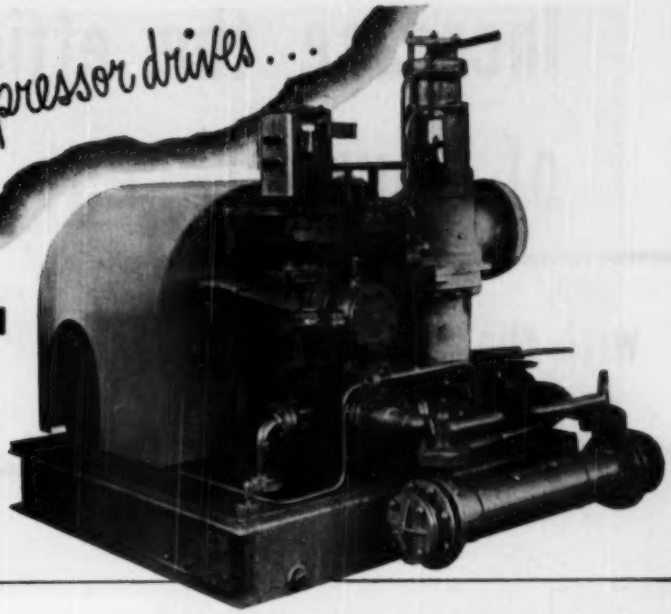

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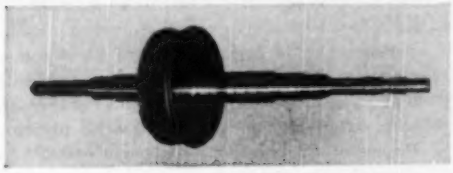
Meeting the demand for steam turbine drivers for high speed machines, Worthington has developed a line of high speed turbines, many of which are already in operation. Smooth, steady driving power for blowers and centrifugal compressors is assured by a powerful oil relay governor — usually arranged for variable speed, either manually or through an outside controller.



Typical of the rugged construction of these turbines, the rotor illustrated is a single solid forging, with wheels and shaft integral. This rotor develops 3860 hp at 9150 rpm when supplied with steam at 600# G, 750° FFT and 185# G exhaust.

For Your Motor Driven Centrifugal Compressors

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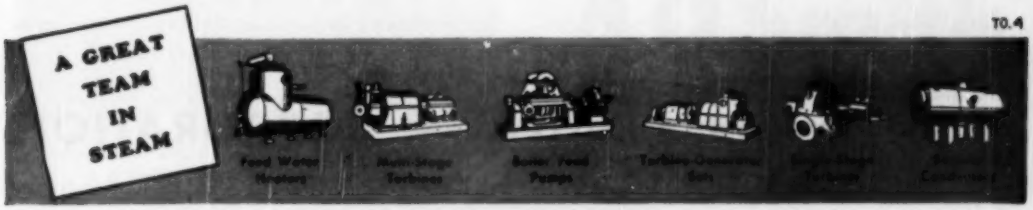
Get the facts on how these money-saving, always dependable turbines and gears prove *there's more worth in Worthington*. Write to *Worthington Pump and Machinery Corporation, Steam Turbine Division, Wellsville, New York.*

SEE OUR CATALOG IN THE COMPOSITE CATALOG

WORTHINGTON

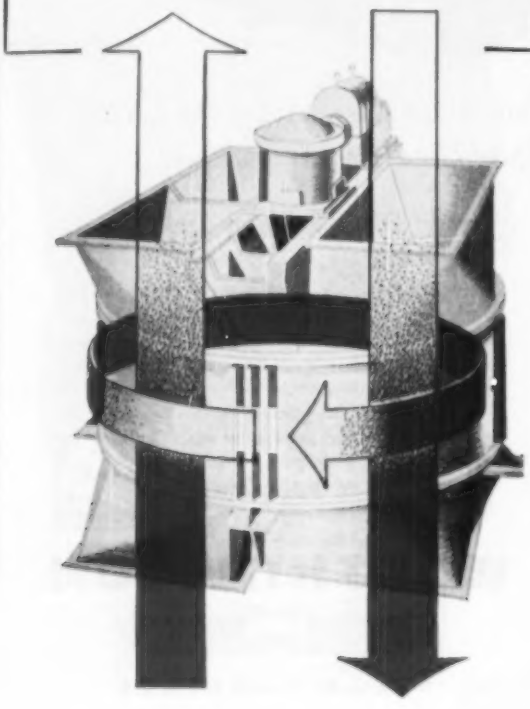
STEAM TURBINES

TO.4



Increase the efficiency of your present boiler

with the *Ljungstrom* AIR PREHEATER



The installation of a Ljungstrom air preheater on your present boiler offers the opportunity for considerable fuel savings that will more than offset the initial cost of the preheater in a matter of a few years.

The regenerative counterflow principle of the Ljungstrom permits operation at lower exit gas temperatures . . . assuring increased heat recovery and reducing the amount of fuel required. Moreover, the compactness and lightness of the preheater makes it possible to install it on your present boiler with minimum change in the existing structure.

For more information as to how you can approach modern performance standards with a boiler that is operating without an air preheater, or with out-of-date air preheater, write to the Air Preheater Corporation. Our engineers will welcome the opportunity to show you how the Ljungstrom can raise the over-all efficiency of your plant.

The Ljungstrom operates on the continuous regenerative counterflow principle. The heat transfer surfaces in the rotor act as heat accumulators. As the rotor revolves the heat is transferred from the waste gases to the incoming cold air.

THE AIR PREHEATER CORPORATION

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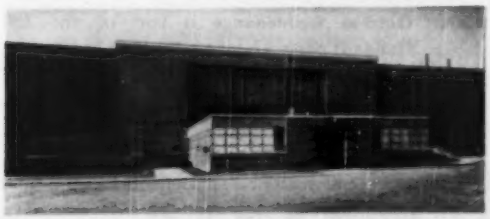
In every aspect of the A. O. Smith Heat Exchanger Plant you find the specialization that implements the A. O. Smith creed of the search for "A Better Way."

A.O. Smith Expands Facilities for Heat Exchanger Engineering and Production

When it comes to the design and building of heat exchangers, now more than ever it pays to go to A.O. Smith. Here, greatly expanded facilities plus top engineering and production talent are joined with modern machine tools and equipment for one big reason: To get the job done *right.*

Specialization is the keynote of the A. O. Smith approach—in heat exchangers as in other fields. Concentrated within the modern plant shown on this page is everything it takes to solve the most complex problems of heat exchanger design and construction. Specialists in heat exchanger engineering and metallurgy. Supervisors and mechanics with the know-how that comes only from long experience. Plus the time-proved A.O. Smith skill in both welding and metal fabrication.

If you have a heat exchanger problem—see A.O. Smith!



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HEAT EXCHANGERS

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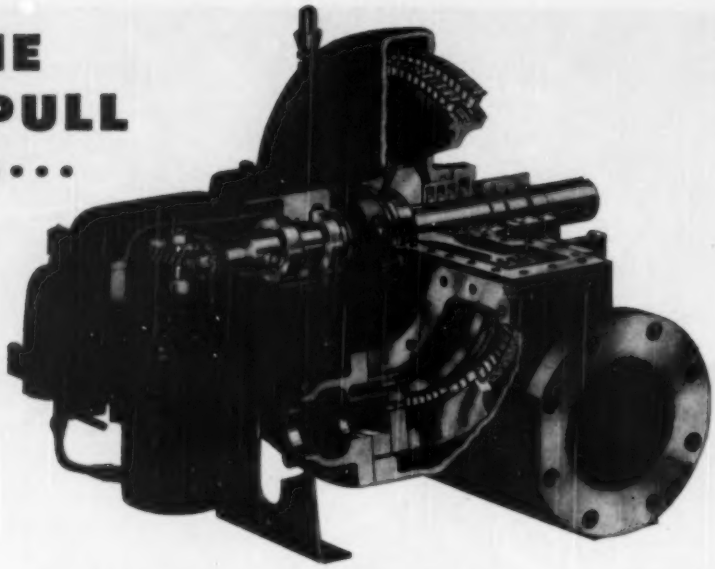
Houston 2 • Los Angeles 12 • New York 17 • Philadelphia 3
Phoenix 2 • Pittsburgh 19 • Salt Lake City 1 • San Diego 1
Seattle 1 • Tulsa 3 • Washington 6, D.C.
International Division: Milwaukee 1

FOR THE LONG PULL AHEAD···



DRIVE RELIABILITY WILL

TYPE DP TURBINES

With American industry once more placing its major emphasis on increased production, plant equipment must be ready for severe tests. One of the sure ways of keeping output high is the use of production tools with high reliability records.

Reliability in equipment drives means more than just the initial ability to meet specified performance ratings. You want to rely on the drive for trouble-free service after months of continuous operation. You want accuracy and economy to remain high with no loss in production time for special maintenance.

If your plant uses turbine drives, select the mechanical drive turbine that's designed for dependability under all operating conditions—General Electric's Type DP. From the totally enclosed governor to the durable babbitt-faced bearings, DP construction will provide greater productivity through greater reliability.

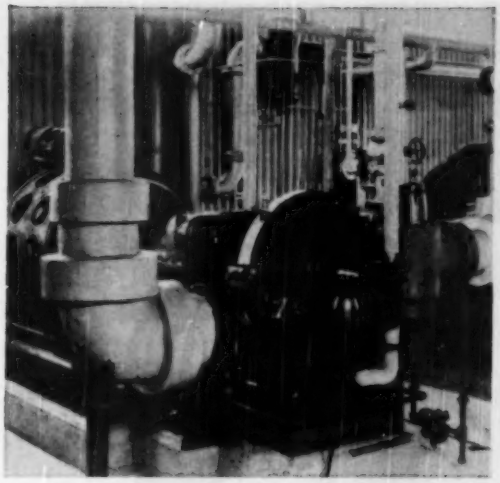
Totally Enclosed Oil Relayed Governing system has no mechanical linkages and few moving parts. It can't stick, gum or rust, even during long standby periods. You can always depend on the DP governor for accurate control over a 30% adjustable speed range.

Positive Lubrication adds years to the life of the turbine. Oil is fed under pressure to grooves in automotive-type, babbitt-faced bearings that also absorb shaft thrust and maintain accurate wheel clearance. A strainer assures that only clean oil is pumped to the bearings and governing system.

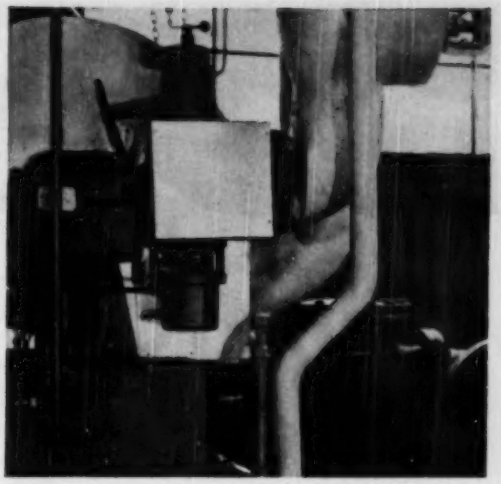
Rugged Construction and Quality Materials provide resistance to erosion and corrosion. Special steel nozzle plate, self-lubricating graphite packings, and Monel-sprayed shaft are examples of design features that keep parts replacement to a minimum.

Easier, Quicker Maintenance is part of the DP design. Standard parts are easily stocked for routine replacement. Disassembly is simplified by the use of socket-head cap screws throughout the turbine.

If you're not familiar with the DP turbine, why not write for a free copy of bulletin GEA-4955A. Or, if you prefer, call your nearest General Electric sales office. ***Apparatus Dept., General Electric Company, Schenectady 5, N. Y.***

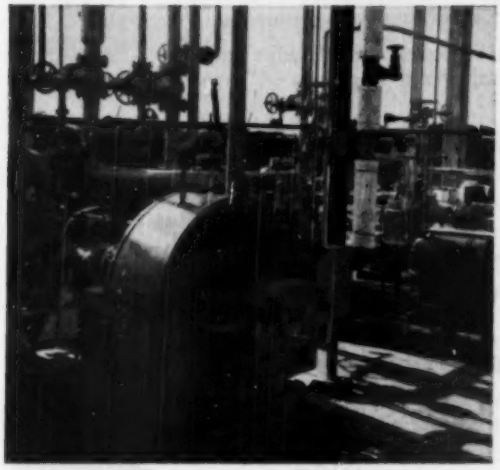


Here a 100 kw generator is driven through a gear coupling by a standard DP turbine. This kind of assignment requires accuracy and reliability such as you would expect only from much more expensive turbines.

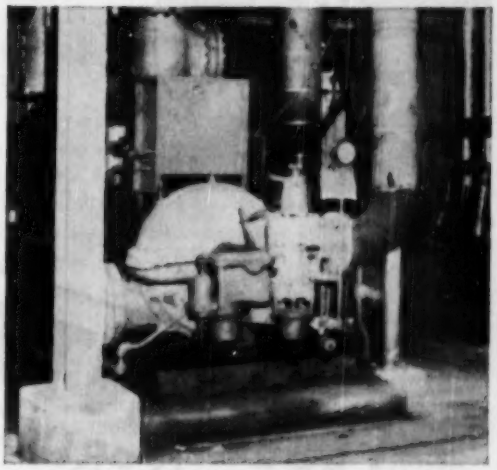


The DP turbine's totally enclosed governing system is always ready for immediate service—even after long periods of idleness. In this West Coast sawmill, DP's are used to drive standby fire pumps.

BOOST YOUR PRODUCTION



You can install the DP anywhere—indoors or outdoors—without fear of parts corrosion. This standard DP is driving centrifugal pumps in an outdoor refinery installation.

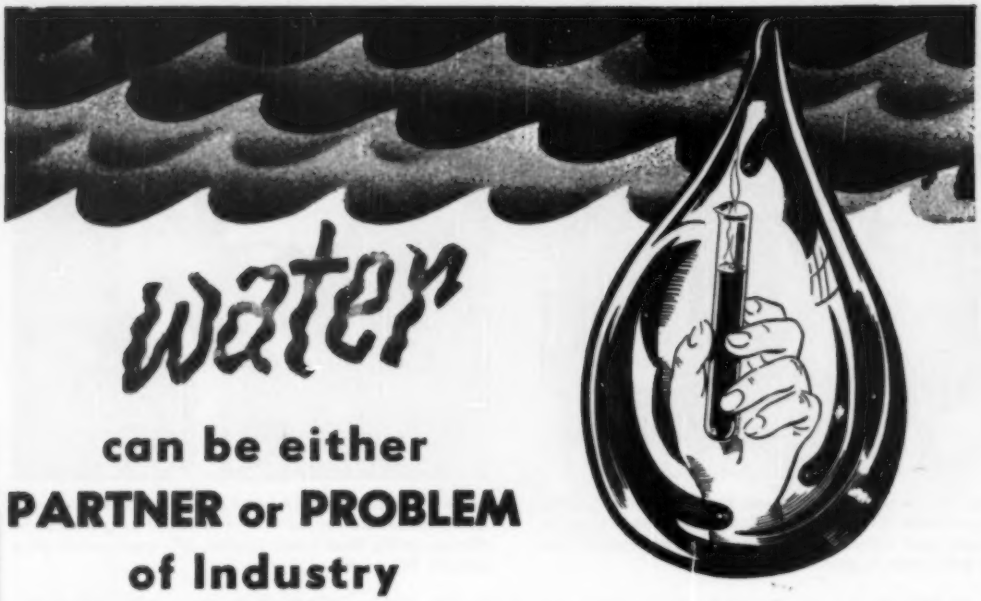


In this refinery, DP turbines drive pumps used in the catalytic cracking process. Since installation, the turbines have provided dependable service—essential for important, continuous processes.

DP stands for Dependable Power

GENERAL ELECTRIC

252-49



water

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Hall—consultants on boiler and industrial water problems.

Buromin—water-treating chemicals, testing equipment, etc. (licensees under Hall Patents).

Calgon—prevention of scale and corrosion in municipal water supplies — "thresholdtreatment."

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You'll save a lot in maintenance costs alone, if you standardize on the Series 700V for high fluid velocities. Call in your local Honeywell engineer for complete information . . . he is as near as your phone!

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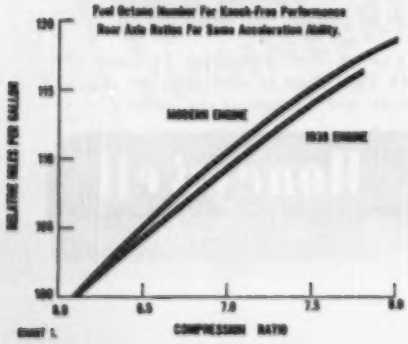
Honeywell
VALVE PRODUCTS

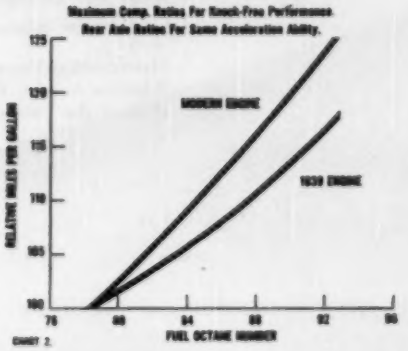
Value of "lead" to refiners increased by modern engine design

Today's engines of advanced design utilize fuel antiknock quality more effectively . . . enable tetraethyllead to deliver more miles per gallon to motorists.

EFFECT OF PROGRESS IN ENGINE DESIGN ON INCREASE IN FUEL ECONOMY FROM HIGHER COMPRESSION RATIOS



EFFECT OF PROGRESS IN ENGINE DESIGN ON INCREASE IN FUEL ECONOMY FROM BETTER GASOLINES



IT IS A FACT that "two gallons of today's gasoline will do the work of three gallons of 1925 gasoline." Since tetraethyllead was first marketed more than twenty-seven years ago, tremendous advances have been made in the gasoline refining and automotive engine design. It now appears that as gasoline and engines are further improved, tetraethyllead will become even more valuable to the refiner, the engine designer and the motorist.

Comparison of a 1939 engine and modern engine, both representative of the best design for each period, indicates that more effective use of octane numbers is being made today. In the Ethyl Laboratories extensive dynamometer data relating to engine performance and fuel antiknock quality were obtained on both engines. Later the engines were installed in cars so that complete data could be obtained on the road.

Modern design gives 10% improvement

When fuel of 78.3 octane number with proper compression ratio was used, the maximum brake mean effective pressure at 1000 revolutions was 104.3 lb. per square inch for the 1939 engine and 114.5 for the modern engine. Gasoline consumed per hour in the development of one horsepower at 1000 RPM and a throttle setting corresponding to a level-road speed of 20 MPH was 1.08 lb. for the 1939 engine and 0.91 lb. for the modern engine.

If the modern engine had been installed in the 1939 automobile and had been operated at the proper compression ratio for 78.3 octane gasoline, the acceleration and hill-climbing performance of the car would have been about 10% better and gasoline economy improved at least 10%. Obviously the modern engine makes more efficient use of gasolines having antiknock quality typical of the late prewar period.

Better use of TEL at higher compression ratios

The charts compare the improvement in gasoline economy of the two engines as the compression ratio was increased to take advantage of the better fuels marketed since 1939. Chart 1 shows the relative fuel economy as the compression ratio was increased from 6.1. The actual fuel economy of the modern engine at 6.1 compression ratio was better than that of the 1939 engine; however, as two different automobiles were used, the road fuel economy of each engine at 6.1 compression ratio has been arbitrarily established at a relative value of 100. The divergence of the curves indicates that the modern engine had about 11% greater rate of improvement in gasoline mileage as compression ratio was increased.

In the utilization of "chemical octane numbers," the modern engine is far superior. In addition to the aforementioned larger gain in economy *per compression ratio*, the modern engine permitted a considerably greater increase in compression ratio *per octane number*. The combined effect of these two advantages is indicated in Chart 2 which shows the relative percentage increase in gasoline economy of the same two engines on the road when the compression ratio was increased from that permissible with fuel of 78.3 octane number to that suitable for 92.8 octane fuel, at constant acceleration ability. The improvement for the 1939 engine was about 18%, whereas that for the modern engine was 25%, or 39% greater.

The more effective use of fuel antiknock quality by modern engines of advanced design enables tetraethyllead to deliver far greater benefits. This is shown in Chart 3, in which road-test data show that 3.0 cc tetraethyllead added to an average base stock for 1949 premium gasoline permits an increase in the compression ratio of the 1939 car which yields 12.3% gain in fuel economy. In the modern engine, the same amount of tetraethyllead yields 18.4% increase in fuel economy. Thus, in the modern engine, tetraethyllead is worth about 50% more on the basis of gasoline economy . . . and as engines are further improved, it will be worth more and more to the refiner seeking to give the public an ever-increasing value.

EFFECT OF PROGRESS IN ENGINE DESIGN ON INCREASE IN FUEL ECONOMY FROM TETRAETHYLLEAD ADDED TO AVERAGE BASE FOR PREMIUM GASOLINE

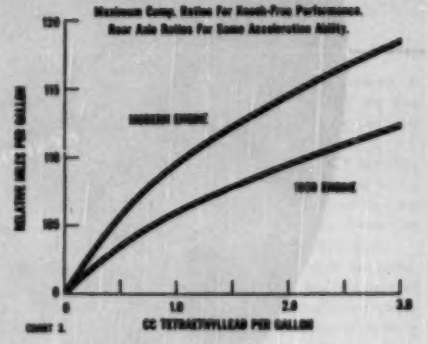


CHART 3.

Over 400 specialists working full time on fuel and engine developments

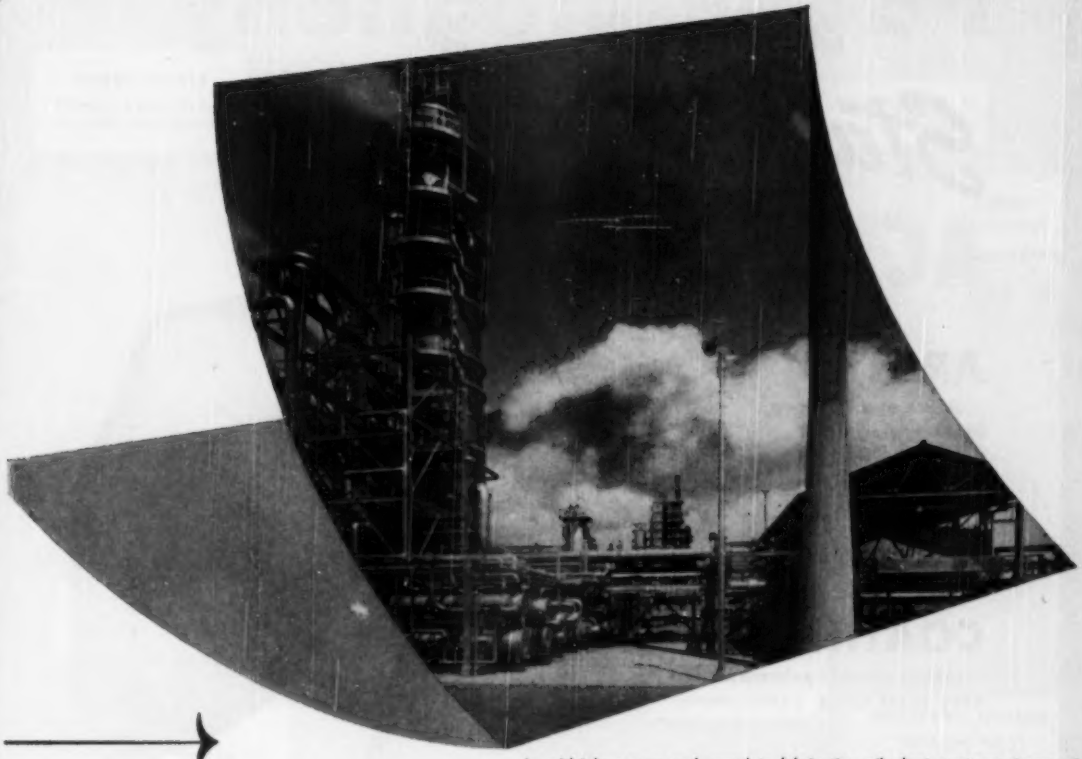
ETHYL CORPORATION
RESEARCH LABORATORIES

DETROIT, MICHIGAN
1600 West Eight Mile Road

SAN BERNARDINO, CALIFORNIA
2600 Cajon Road

NEW LUBE OIL PLANT FOR SOHIO

designed and built by LUMMUS



In mid-July a new and complete lubricating oil plant went on stream at SOHIO's large Lima refinery. Lummus designed and built four of the five processing units which will produce approximately 1800 barrels per day of high grade lubricating oils.

Lummus applied new and improved techniques in the design of SOHIO's lube-oil plant. A new fluidized method of clay handling is employed in the contact units. A hot oil-belt system provides all the heat required for the FURFURAL, MEK, and CLAY-CONTACT Units. A single console instrument panel is used to control the operation of the FURFURAL and MEK Units.

The Lima plant reflects the leading role Lummus has played in the building of outstanding lube-oil refineries. Lummus has designed and constructed over 115 lubricating oil processing units. To a study of your individual problems, whether solvent refining, the modernization and expansion of existing units, or new projects, Lummus can add the experience gained through years of designing and building petroleum, petroleum chemical and chemical plants.

PETROLEUM HORIZONS, the new 80-page book on Lummus processes and plants, features a step-by-step description and flow sheets for 31 refinery processes. Your copy available on request.

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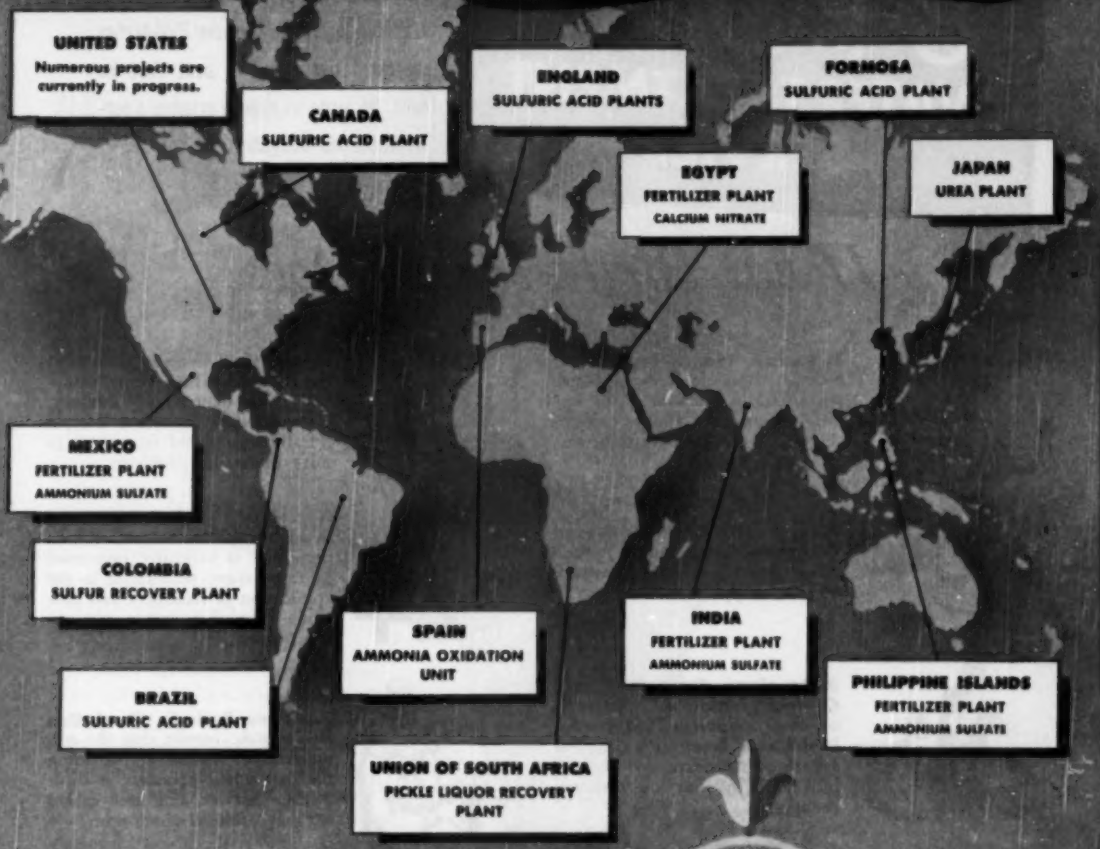

All the projects pinpointed above are now under way. These are in addition to the more than 600 Chemico installations already completed during the past 36 years, many in countries not mentioned above.

CHEMICAL CONSTRUCTION CORPORATION

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Even if your present water treatment methods appear satisfactory, it will pay you to look into Bird-Archer's 8-point water treatment service. Any or all of this comprehensive, efficient service is available to you. Talk to your Bird-Archer representative about it next time he calls. Or, write us now to arrange a consultation. No obligation, of course.

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5. Furnishes Proper Chemical Treatments When Required—For more than a half century, Bird-Archer has manufactured specifically formulated treatments to solve individual problems.

6. Instructs Plant Staff—Plant personnel is carefully instructed by experienced technicians in the application of treatment and control . . . teaches simple, accurate test procedures.

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Quick service on your carbon, alloy, and stainless tubing requirements is available through your nearest B&W Tube Representative, factory-trained in cost-saving "tube-technics" . . . and from local distributors in principal cities.

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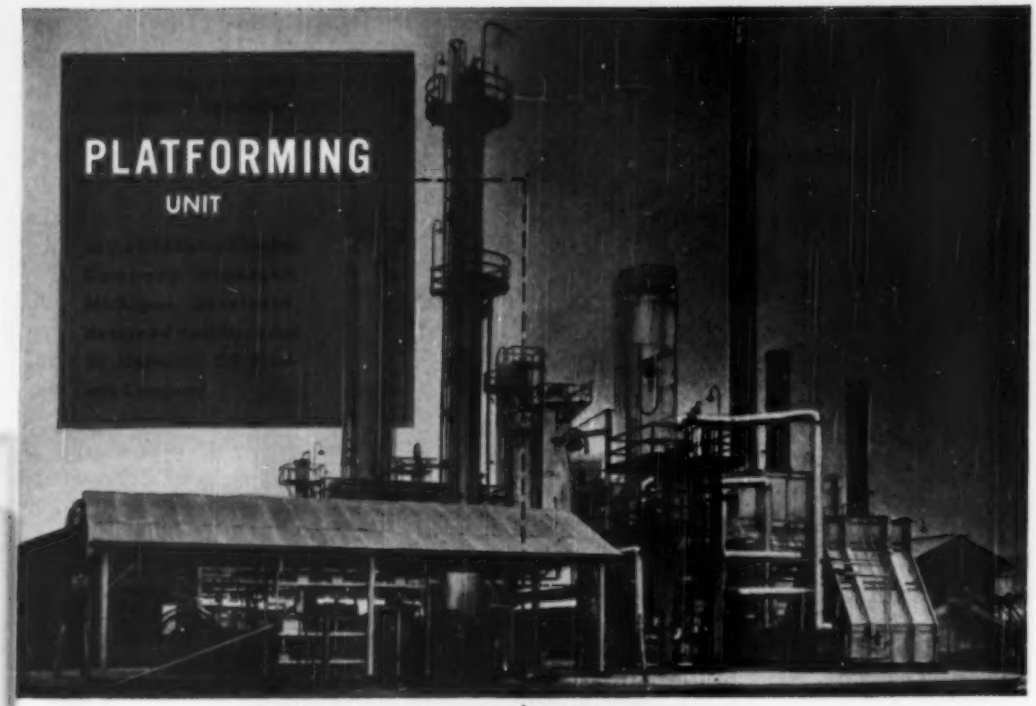

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Dependable tightness . . . the industry's invariable valve safety standard . . . here called for valves that consistently hold material running as high as 90% hydrogen, and in the particular instance of the reaction chamber, function precisely under approximately 900 PSI set pressure at 1000° F.

Consolidated Safety Relief Valves were selected to do the job. For Consolidated outside bevel seat and floating guide construction positively eliminates leakage under *discharge piping stresses*. Only Consolidated Safety Relief Valves have that all-important and exclusive extra safeguard of *built-in fixed capacity* . . . independent at all times of the position of multiple adjustable blow-down rings. One adjustment controls blow-down . . . cannot be altered accidentally during maintenance . . . lift or secondary annual orifice area is not disturbed.

This is one of the many Consolidated Safety Relief Valves installed throughout the new Platforming Unit of the Old Dutch Refining Company.

The basically simple design (25% of the parts used in ordinary safety valves are eliminated), assures much lower maintenance costs and also minimizes standardization problems.

These "open secrets" of Consolidated design and construction are the key to safety . . . as well as simple economical, long-time operation however severe valve service conditions may be.

See your local distributor for complete information

CONSOLIDATED SAFETY RELIEF VALVES

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BROWN *Integral* "*One-Piece*" FINTUBES

IN SIZES, DESIGNS AND METALS TO MEET ANY HEAT TRANSFER REQUIREMENT

● Brown Integral "One-Piece" Fintubes avoid the air-gap which is present when a mechanical bond is used. Consequently Brown Fintubes:

1) permit heat to flow between the fins and the center tube freely, and at high efficiency;

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3) permit the use of thinner walled center tubes (if this is desirable), saving weight and increasing the heat transfer efficiency; and

4) assure users of long, efficient and trouble-free operation during the entire life of the tube.

Furnished in a wide variety of sizes, designs and metal analyses for a great variety of heat transferring applications. Engineering assistance and samples for experimental work furnished gladly. Let us work with you on your requirements.

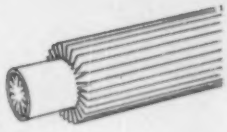
ALUMINUM

Integral construction. Center tubes to 1½" pipe size. Any number or height of fins.

Outside Fins without Alclad Liner

Outside Fins with Alclad Liner

Outside and Inside Fins



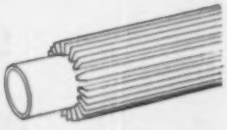
STEEL (low carbon)

U-shaped channels, resistance welded to the center tube. Tubes from ¼" to 8" pipe size. Fins in multiples of 4 to 40 or more, depending upon tube circumference.

Outside Fins

Inside Fins

Outside and Inside Fins



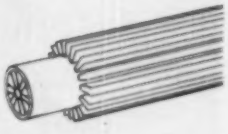
STAINLESS STEEL (any alloy)

U-shaped channels, resistance welded to the center tube. Tubes from ¼" to 8" pipe size. Fins in multiples of 4 to 40 or more, depending upon tube circumference.

Outside Fins

Inside Fins

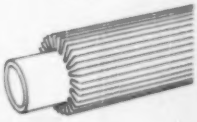
Outside and Inside Fins



MONEL

Resistance welded integral construction. For installations where monel is required for corrosion resistance.

Outside Fins Only



INCONEL

Resistance welded integral construction for high temperature, corrosion resistant services.

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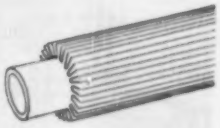

ADMIRALTY (and other copper alloys)

Integral "One-Piece" construction (brazed). Widely used in cooling and condensing operations to resist water corrosion. Center tubes to 2" pipe size,—larger on special order.

Outside Fins Only

THE BROWN FINTUBE CO.
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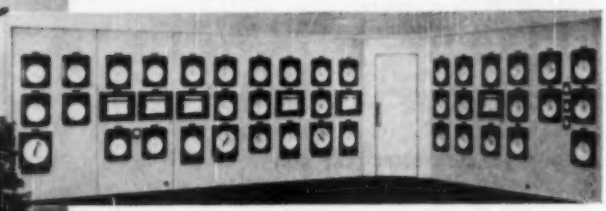
Sun Oil, Toledo, goes on stream with first big Houdriflow units...

... under Foxboro M-40 Control

When Sun Oil Company's new Plant 5 at Toledo, Ohio, went on stream last May, 81 Model 40 Controllers took over critical control functions. Without any manual "juggling", process variables came directly to their control points, because M-40 met the preset values so exactly. And the inherent accuracy of the M-40 *held* them there, continuously!

This first major installation of Houdriflow "cat" crackers offers another outstanding example of the petroleum industry's preference for Foxboro M-40, "the finest modern controller"!

The Foxboro M-40 Controller gives you the benefit of the most advanced developments in pneumatic instrument design. Its rigid unit construction and almost frictionless moving parts result in greater power, accuracy and response. Available for temperature, pressure, flow, level and other applications.
Write for details. **The Foxboro Company, 74 Neponset Ave., Foxboro, Mass., U.S.A.**

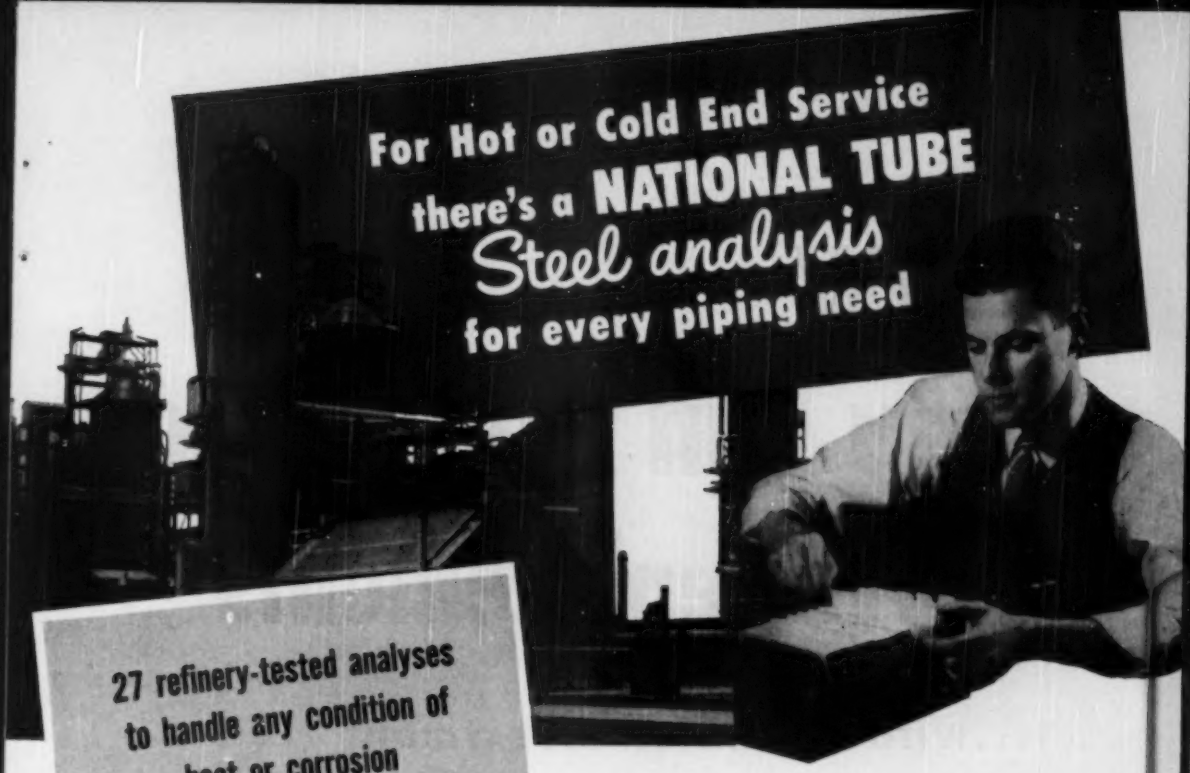


Section of Plant 5 control room at Sun Oil showing a few of the 81 Foxboro M-40 Controllers.

Sun Oil's revolutionary new Plant 5 at Toledo—a 309-ft. quadruple-reactor catalytic cracking unit.

FOXBORO
REG. U. S. PAT. OFF.
CONTROLLERS

For Hot or Cold End Service there's a NATIONAL TUBE *Steel analysis* for every piping need



27 refinery-tested analyses to handle any condition of heat or corrosion

Low Carbon	7 Cr, ½ Mo
Low Carbon, ½ Mo	8 Cr, ½ Mo
Low Carbon, 1 Mo	8 Cr, 1 Mo
½ Cr, ½ Mo	9 Cr, ½ Mo
1 Cr, ½ Mo	9 Cr, 1 Mo
1¼ Cr, ½ Mo	12 Cr, Al
2 Cr, ½ Mo	17 Cr
2¼ Cr, 1 Mo	27 Cr
2½ Cr, ½ Mo, ¼ Si	18-8
3 Cr, ½ Mo, 1¼ Si	18-8 Ti
3 Cr, 1 Mo	18-8 Cb
5 Cr, ½ Mo	18-8 Mo
5 Cr, ½ Mo, 1½ Si	25-20
5 Cr, ½ Mo, Ti	

IN hot end service—elemental sulphur, hydrogen sulphide and mercaptins can cause real trouble—particularly if salt is present, and when pressures and temperatures are high.

Cold end service can be even worse: In addition to the sulphur compounds in charging stock, we find hydrochloric acid, sulphuric acid, sulphurous acid and many organic acids. And, if polymerization has been used, the cold end products may contain entrained sulphuric and phosphoric acid.

Here's the point: varied as your experience may be, you can't go wrong if you get free advice from the world's largest manufacturer of tubular products—National Tube Company. We have a tremendous file of case histories that deal with practically every known condition or *combination* of conditions that cause premature pipe and tubing failure. There's a good chance that your problem is a matter of recorded history in our files—solved by one of our 27 refinery-tested analyses.

In the event that yours is a totally *new* condition, our long experience will be of great help in selecting the proper alloy to do your particular job.

NATIONAL TUBE COMPANY, PITTSBURGH, PA.
(Tubing Specialties Division)
COLUMBIA STEEL COMPANY, SAN FRANCISCO
PACIFIC COAST DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS

NATIONAL SEAMLESS PIPE AND TUBES

UNITED STATES STEEL

How you can up-grade valve replacements

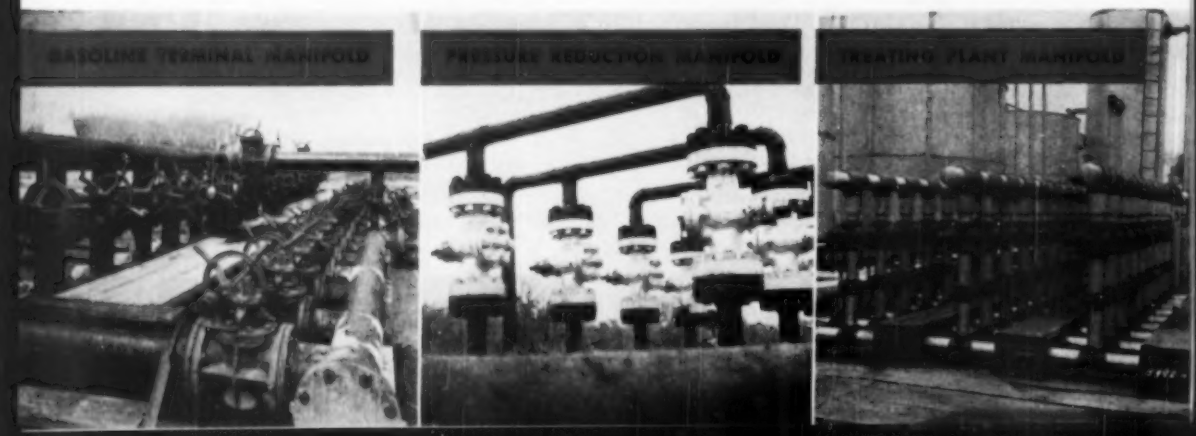
...without major investment

Why does a valve need replacing? Because it has either failed to operate, or cannot adequately handle the fluid. Replacing old style valves with like valves is usually force of habit—and it's easy to become a victim of habit. The way to break a bad habit is to substitute a new and better habit.

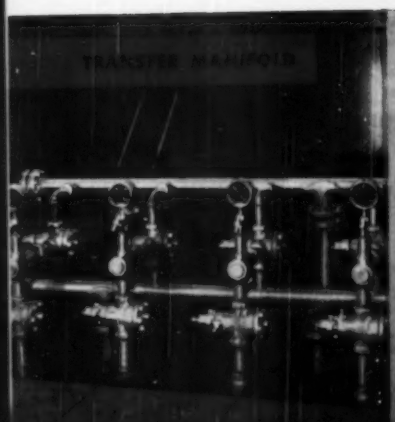
Get the Nordstrom habit. Every time you make a valve replacement, install a Nordstrom. You thereby gradually build up the standards of valve quality in your plant.

Take a manifold, for example. It may have a dozen or so old valves, some of which are giving you trouble. Requisition a Nordstrom for each replacement. Eventually the entire manifold will be 100% Nordstrom—completely modernized, trouble-free, leak-free, equipped to save operator's time—and, with Hypermatic, *automatically lubricated.*

Try this money-saving habit. Step up plant efficiency. Keep upkeep down with Nordstroms.



Adopt a progressive program of replacing obsolete valves with Nordstroms

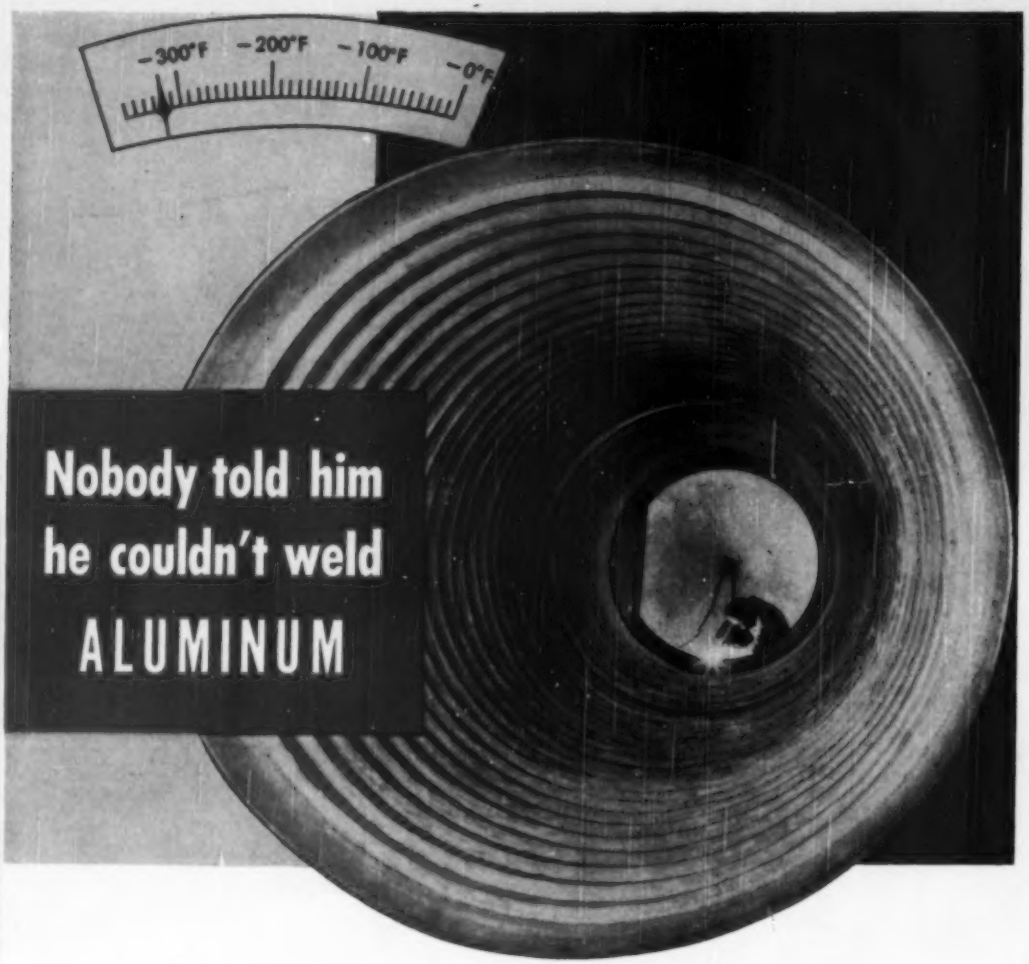


Nordstrom Valves

AUTOMATICALLY LUBRICATED

ROCKWELL MANUFACTURING COMPANY

400 N. Lexington Ave. • Pittsburgh 8, Pa.
Atlanta, Boston, Chicago, Columbus, Houston, Kansas City, Los Angeles, New York, Pittsburgh, San Francisco, Seattle, Tulsa . . . and leading Supply Houses.
Export: International Division, Rockwell Manufacturing Company, 7701 Empire State Bldg., New York, 1, N.Y.



So he's welded 37 aluminum rings—7 feet in diameter—into this low-pressure oxygen plant, bubble cap tower of Alcoa Aluminum. And very nicely, too. Welding aluminum is no harder than welding other metals. Just follow recommended, simple procedures and you'll have smooth, tight joints every time. Gas, arc, resistance . . . aluminum takes them all.

But ease of welding is only one of the reasons you'll want aluminum for sub-zero process equipment. It costs 25 to 50% less than other suitable metals. Alcoa Aluminum gets stronger and tougher as temperatures drop. Shows no signs of embrittlement at temperatures down to -320°F and lower. Use of aluminum speeds fabrication, reduces maintenance and increases the efficiency of exchangers and expanders.

For more information, mail the coupon below to: ALUMINUM COMPANY OF AMERICA, 1476M Gulf Building, Pittsburgh 19, Penna.

Gentlemen:

Please send more information on aluminum's properties and applications for sub-zero process equipment.

Name_____

Title_____

Company_____

Address_____

City_____ State_____

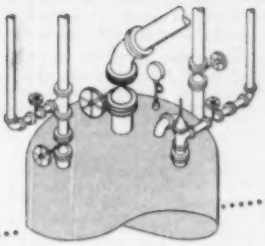
ALCOA
first in
ALUMINUM

BASED ON FACTS REPORTED BY A CRANE VALVE USER

5 times-plus longer service

with dependable

CRANE VALVES



PROBLEM: To find a better replacement for valves that needed repairs every 2 to 3 weeks and failed completely in 3 to 4 months.

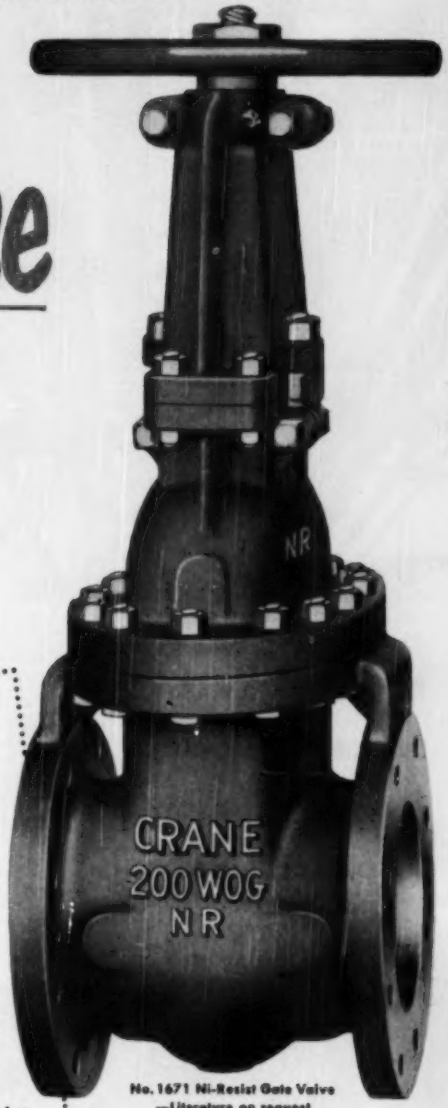
WORKING CONDITIONS: Valve exposed constantly to hydrochloric acid vapors at 50 psi, at approximately 280° F., while controlling raw material inlet line to starch converter.

SOLUTION: Crane No. 1671 Ni-Resist Cast Iron Gate Valve with Crane 18-8 Mo Alloy trim.

RESULT: On last inspection, after 19 months' service without one single interruption, Crane Ni-Resist valves were still in very good condition.

Here's an example of the long life and low-cost maintenance that make Crane Quality the best value in all types of valves.

More CRANE VALVES are used than any other make



No. 1671 Ni-Resist Gate Valve —Literature on request through your Crane Branch or Crane Wholesaler.

CRANE

CRANE CO., *General Offices:* 836 S. Michigan Ave., Chicago 5, Ill.
Branches and Wholesalers Serving All Industrial Areas

VALVES • FITTINGS • PIPE • PLUMBING • HEATING

This close-up clearly shows the ribs or corrugations which add strength to Childers Jacketing and also make it form more easily around lines. Aluminum strapping and seals are a quick, inexpensive way to attach the jacketing. They can be used without any special tools and take no special training for the installers.

Does long lasting aluminum cost too much for covering your insulated lines? Not when you specify this new type weatherproof jacketing. It has been specially developed to cost little more than ordinary temporary jacketing materials.

New Low-Cost Jacketing Cuts Maintenance on Insulated Lines

AT LAST an aluminum jacket has been "engineered" especially to protect outdoor lines in refineries and chemical plants. It is the first "permanent-type" jacketing that offers both low initial cost and low application cost.

After two years of tests and major installations at 431 outdoor locations in refineries, chemical plants, and power plants, the Childers Manufacturing Co. of Houston has rung up an impressive cost-cutting record with their Childers Aluminum Jacketing.

Secret behind this low cost is the thin aluminum sheet—.006" thick—which is the weather-protecting sheath of the jacketing. It is ribbed (as pictures show) for extra strength and to facilitate forming around the line. This aluminum has proved thick enough to resist weathering and usual abrasion, but costs much less than heavier aluminum sheets.

Easy application of this Childers Jacketing cuts labor bills drastically. It comes from the factory in easy-to-handle rolls that are four feet wide and either 100 feet or 200 feet long. It is light and flexible to handle as the men put it on the line. No roll forming required as with heavy, un-crimped material. It can be cut off and attached just the same as the old-fashioned tar-paper that was sometimes used for jacketing.

You can attach Childers Jacketing around your insulated lines by one of several easy methods. The use of aluminum strapping and seals is probably the best. Sheet metal screws or Minnesota Mining's No. 471 tape can also be used.

The Childers jacketing can be removed and re-used.

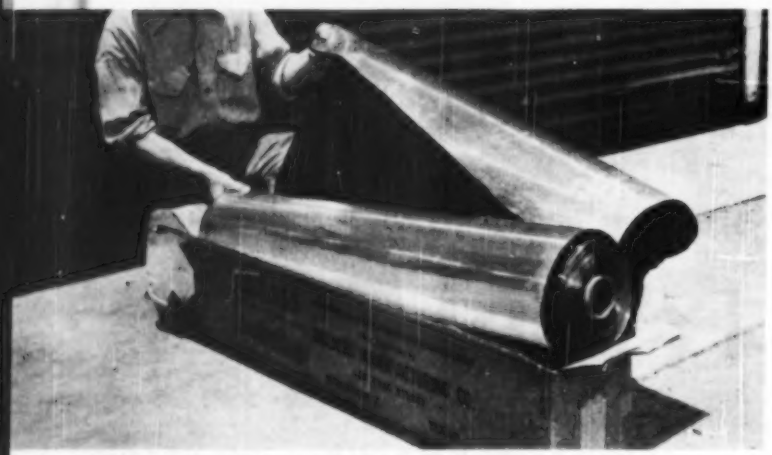
A moisture barrier is attached to the back of the jacketing to give positive protection for the aluminum when it is used with alkaline insulating materials.

No painting, no rust-proofing, little maintenance—that's the advantage of aluminum!

Hundreds of design engineers and maintenance engineers have agreed they save money for their firms and trouble for themselves by changing their jacketing specs to Childers 100%. That should make it worth your testing too—and a test roll costs only $36.00 for 400 sq. ft. (with moisture barrier attached—price for jacketing without moisture barrier much less). That's a good investment in any plant.

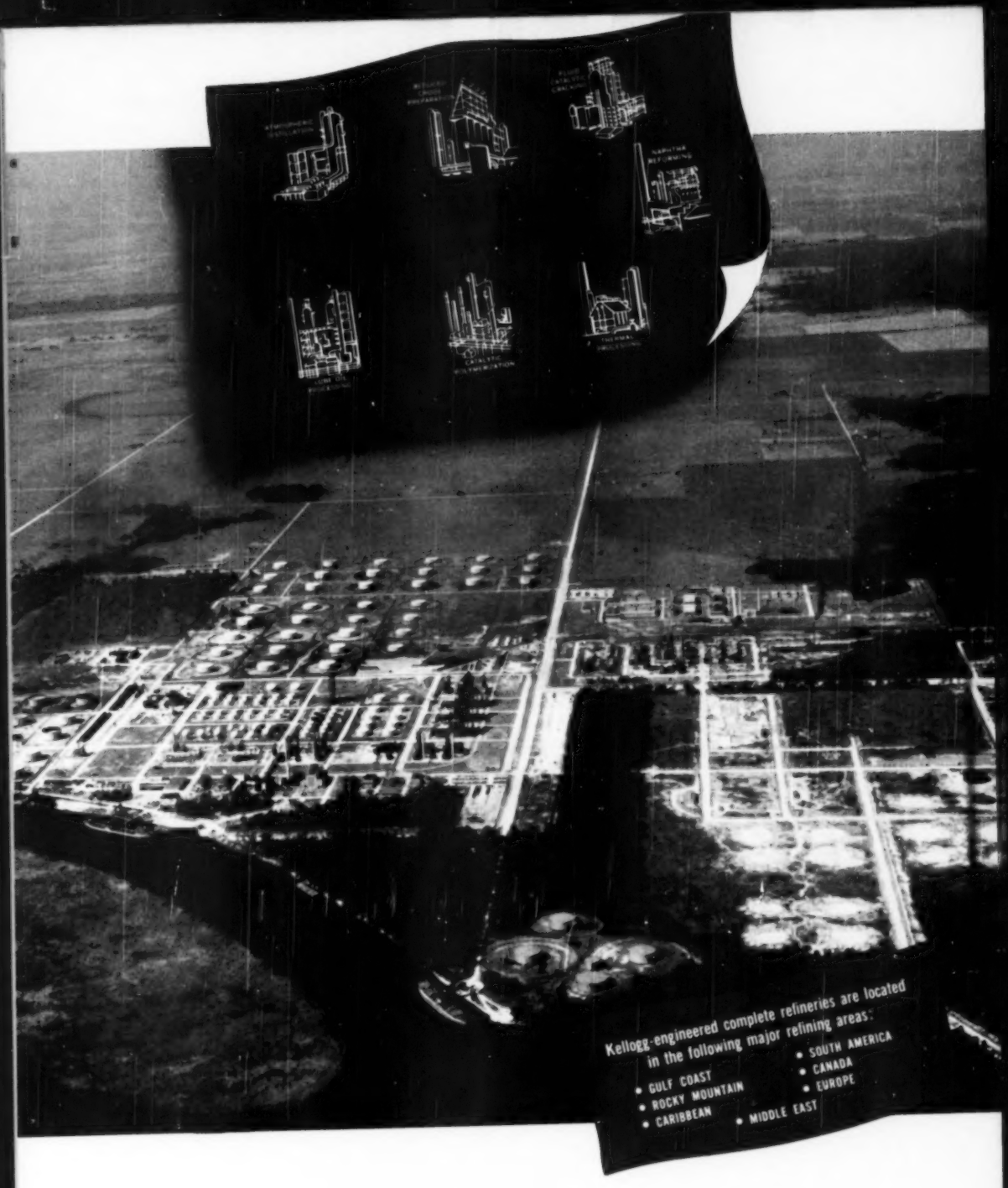
* * *

FOR FULL INFORMATION write Childers Manufacturing Co., Dept. PR-2, 625 Yale St., Houston 7, Tex., for complete literature. Childers has engineering representatives in principal cities to work with you on specific problems.



This is how Childers Aluminum Jacketing is shipped in easy-to-handle rolls. It is quite flexible, yet stands up under severe weathering.

(AN ADVERTISEMENT)



15 Complete Refineries engineered by Kellogg!

Yes! In addition to more than 450 individual major process units Kellogg has built 10 complete refineries ...with 5 more currently in work!

IN the five short years since the war, Kellogg has undertaken complete responsibility for the engineering and construction of five entirely new refineries in Canada, South America and Europe . . . and in addition has almost matched this task with complete modernizations of three existing refineries. All this in addition to the regular run of individual process unit contracts.

Included in the group of completed jobs are the largest individual contract ever handled by a refinery engineering organization (for a complete 100,000 barrel catalytic refinery at Lake Charles), the original facilities at three of the world's largest refineries (in Abadan, Aruba and Texas City), as well as small and moderate-sized thermal refineries.

No other engineering organization can match that record. Refiners contemplating completely new refineries or major modernizations should investigate the economy and surety of Kellogg *Master* Contracts.

EXPERIENCE, SIZE ARE BASES FOR SUCCESS!

The Master Contract is admittedly a most efficient way for a refiner to handle a major building project. Financial and technical responsibility are centered in one contractor, which has many advantages, chief among which is the fact that a refiner's technical staff is relieved of coordinating details, free to carry on normal activities of maintaining peak efficiency in operating refineries. But unless a refiner can find a contractor with a staff large enough to handle *all* individual phases of a complete refinery *simultaneously*, a project can drag out interminably — thereby costing untold dollars in loss of earning power. Technical personnel in true depth is the basic reason Kellogg has been entrusted with so many major contracts. Of course, today Kellogg also contributes one more "priceless" ingredient to such projects: actual experience gathered over more than a decade of handling the most comprehensive projects in the refinery construction field.

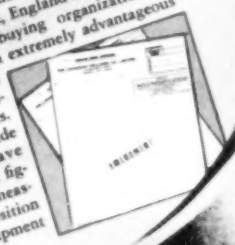
IT TAKES ALL SEVEN TO PRODUCE GREATER EARNING POWER...

1 THE DEVELOPMENT "TOOLS"
—laboratories, pilot plants and recognized specialists to prove and improve processing and equipment ideas.

2 PROCESS ENGINEERING
by three distinct groups of specialists—*sequence* engineers, *unit* engineers and *development* engineers—supported by an extensive reservoir of exclusive data.

3 SPECIALISTS IN EVERY PHASE
of design engineering due to the completeness of Kellogg's engineering staff.

4. WORLDWIDE PROCUREMENT
facilities backed by the cumulative buying power of the largest company in the business. With fully staffed Procurement Offices in Canada, England and France—supplementing the central buying organization in New York—Kellogg is in an extremely advantageous position to capitalize on worldwide markets regardless of currency situations. Kellogg purchases outside the United States have reached well into eight figures, which provides a measure of the Kellogg position in the world's equipment markets.



5 COMPLETE FABRICATING FACILITIES
to make schedule deadlines and to develop workable "firsts" in refinery equipment.

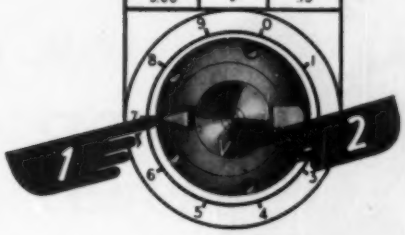
6 CONSTRUCTION KNOW-HOW
acquired in completing hundreds of major jobs, plus an ample supply of the proper tools, and the constant development of new money-and-time-saving methods on the construction lot.

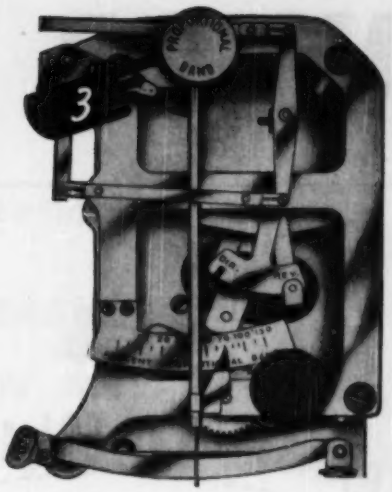
7 PRACTICAL OPERATING COUNSEL
on all design and construction, achieved through practical operating men working as an integral part of the company.

. . . AND ONLY KELLOGG HAS ALL SEVEN!

The M. W. Kellogg Company, (a subsidiary of Pullman Incorporated), New York, Jersey City, Los Angeles, Tulsa, Houston, Toronto, London, Paris

DERIVATIVE TIME	SCALE SETTING	RESET RATE
0	0	0
.1	1	.03
.15	2	.05
.25	3	.08
.40	4	.12
.75	5	.18
1.20	6	.25
2.00	7	.35
3.00	8	.50
5.00	9	.75





if you use . . . or plan to use . . . automatic control instruments

you should investigate

these **THREE EXCLUSIVE ADVANTAGES** you get in

BRISTOL series 500 air-operated controllers

1. Reset Rate . . .
2. Derivative Time . . .
3. Proportional Band . . .

} **ACCURATELY CALIBRATED AND EXACTLY REPRODUCIBLE**

The reset scale is calibrated in actual reset rate. The proportional band scale is graduated in percent of proportional band. The derivative scale is calibrated directly in minutes.

This makes possible the exact duplication of controller adjustments for any process throughout a national organization.

It also makes possible the replacement of controllers on a process with full assurance that such replacements will exactly duplicate the performance of the original—eliminates the cut-and-try method of arriving at the original setting—saves hours by cutting down on shut-down time.

Accurate reproducibility is only one of the many advantages you get in Series 500 Air-Operated Controllers which exemplifies the outstanding instrument engineering Bristol puts into its complete new line of Series 500 recording and controlling instruments—products of over 60 years of instrument experience.

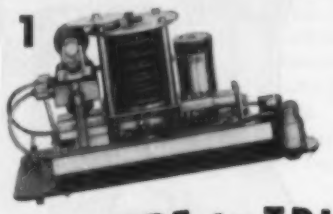
Write for new Bulletin A120 on Series 500 Air-Operated Controllers. THE BRISTOL COMPANY, 111 Bristol Road, Waterbury 20, Conn.

BRISTOL

Engineers process control for better products and profits

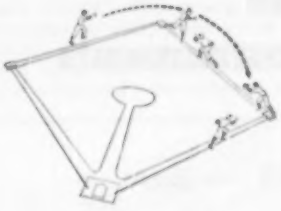
AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

TAYLOR TRANSET*



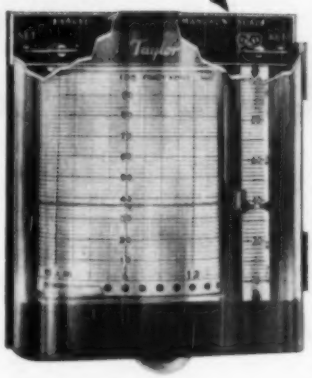
TRANSAIRE to TRI-ACT

to TRANSET



Tinker to Evers to Chance had nothing on Taylor's TRANSAIRE* to TRI-ACT* to TRANSET*. They, too, form a well-coordinated combination. They combine 3 stars to make the fastest, most dependable pneumatic transmission system on the market.

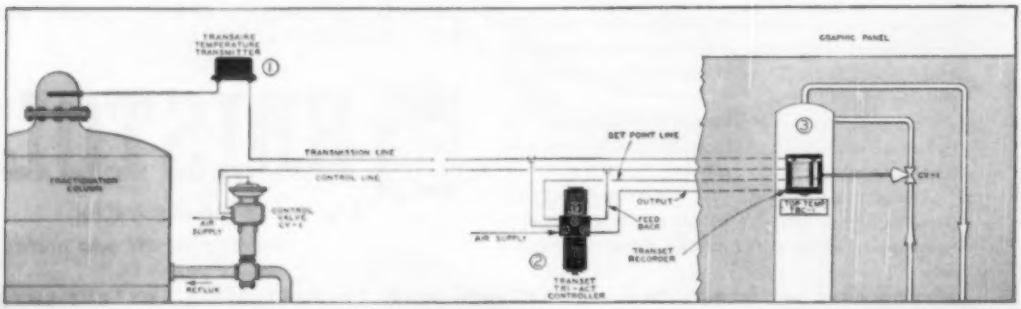
3



1. TRANSAIRE. A force-balance temperature or pressure transmitter. SPEED-ACT* gives rate action in the measuring circuit to compensate for process lags. Narrow range spans. Standard 3 to 15 psi output. Interchangeable unit construction. Temperature and Barometric Pressure Compensations.

2. TRI-ACT Controller. A force-balance controller with a new circuit . . . a new concept in process control. High capacity relay air valve for faster response of control circuit. Wider response adjustments than ever before. Panel or locally mounted.

3. TRANSET Recorder. Fits $3\frac{7}{8}$" x $4\frac{1}{2}$" opening . . . a natural for graphic panels; a great space saver for conventional panels. Powerful actuation—bellows operated rectalinear movement. 30-day chart, 3-hour visible record. Everything needed for remote control.



CONTROL SYSTEM

A new concept in Pneumatic Control:

- ***MORE ACCURATE MEASUREMENT***
- ***CLOSER CONTROL ON ANY PROCESS***
- ***CONTINUOUS SPACE-SAVING RECORDS***
- ***HIGHER PROCESSING EFFICIENCY***

FASTER, more accurate and sensitive measuring devices can't be of maximum value unless the control mechanism can act upon the measured impulses as fast as they occur. Taylor has developed a new controller and a new recorder to take advantage of faster measuring devices, such as TRANSAIRE Temperature and Pressure Transmitters and the Aneroid Manometers for Flow and Liquid Level. These individual developments, each designed to take advantage of the other's superior performance, are now available in a complete system. The result is unprecedented quality of process control.

1. FASTER MEASURING INSTRUMENTS. Taylor's TRANSAIRE, force-balance temperature or pressure transmitters, created new standards in the measurement of *changing or dynamic* temperatures and pressures. TRANSAIRE, with derivative action (SPEED-ACT*), transmits temperature changes with unbelievably fast accuracy. Other advantages: Temperature and barometric compensation; Interchangeable unit construction; Standard 3 to 15 psi output air pressure. On pressure applications, range spans of 20 and 40 psi available throughout range limits of 35 to 415 psia.

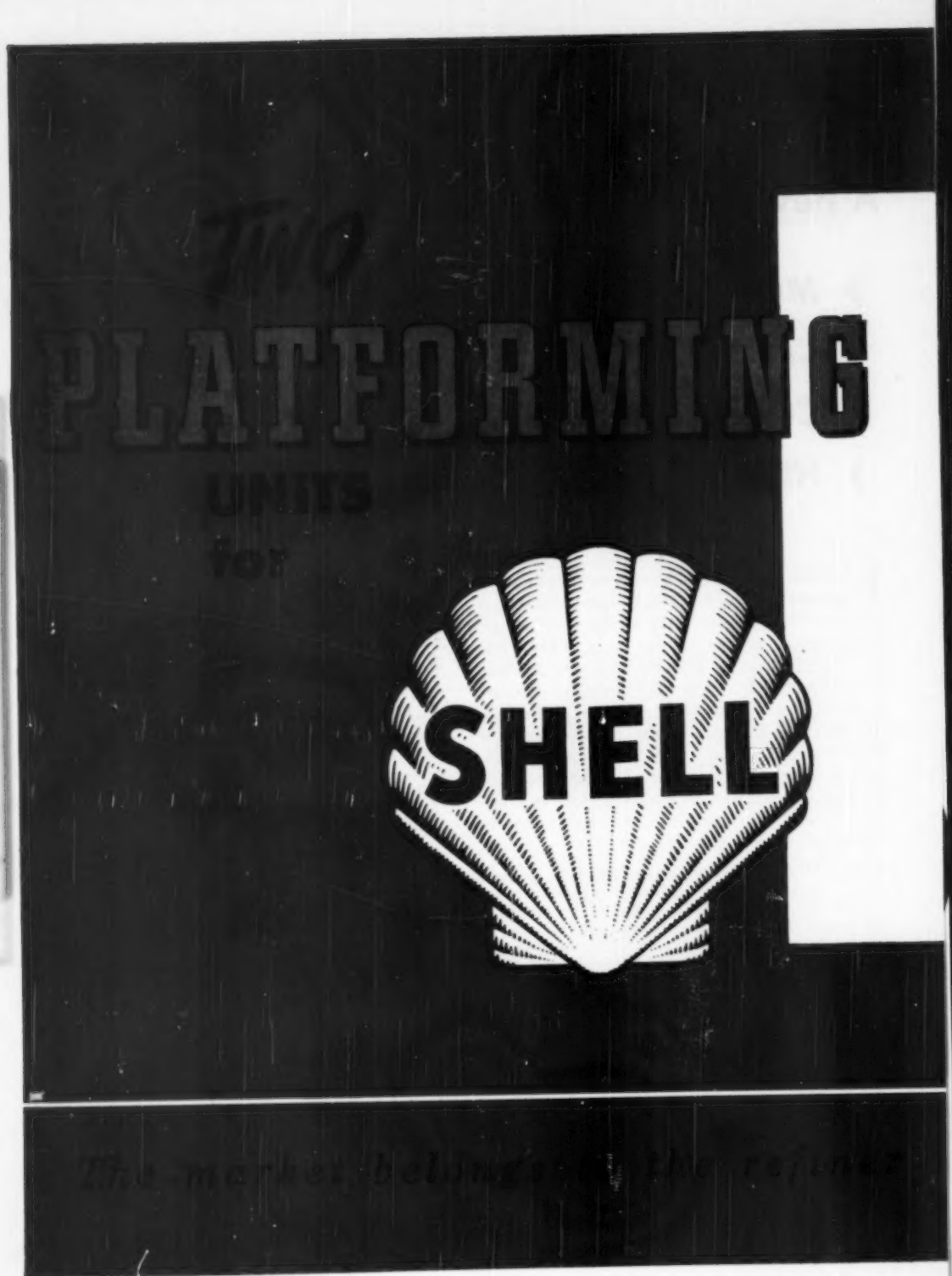
2. FASTER CONTROL with *Stability!* Taylor's new TRI-ACT Controller combines a wider range of response adjustments, an increased capacity relay air valve, and a *new control circuit*, to take advantage of the faster measuring systems. This new force-balance controller permits 4 times faster reset rate and 4 times faster rate action (PRE-ACT*) than conventional controllers. It eliminates overpeaking, and gives faster recovery for load changes on pressure, flow, and temperature applications—because rate action is in *the new circuit*. The new controller is adaptable to *your* process requirements. Can be locally mounted if needed for better quality of control, or panel mounted. You make the decision!

3. MIDGET RECORDER saves space. Taylor's new TRANSET Recording Receiver greatly reduces panel space. Fits 3⅞" x 4½" panel opening, making it especially adaptable to graphic panels. It gives continuous 30-day process record, with 3 hours visible—remote setting of control point—automatic to manual control—instant check on controller performance and the control valve position. ALL THESE—right where you want them. TRANSET Indicator fits into same size panel cut-out. Many parts interchangeable.

We sincerely believe this new Taylor-engineered TRANSET Control System combines the *best transmitter, the best controller, and the best recorder* on the market. It sets new standards in speed, accuracy, and dependability of pneumatic transmission systems. Find out more about it, and put it to work for you! Write for **Bulletin 98097,** and ask your Taylor Field Engineer. *Instruments for indicating, recording and controlling temperature, pressure, humidity, flow and liquid level.*

*Trade-Mark

Taylor Instruments
MEAN
ACCURACY FIRST
IN HOME AND INDUSTRY


Two
PLATFORMING
UNITS
for
SHELL

EACH WILL PROCESS 16,000 BARRELS PER DAY

● Here is further proof of the acceptance of Universal's Platforming process throughout the refining industry . . . among refiners of *all* sizes with marketing patterns of all types. These two units will be erected at the Wood River, Illinois, and the Houston, Texas, refineries of Shell Oil Company.

The first Platforming unit had a rated capacity of 1,500 barrels of charging stock per day. Shell's two units will each process 16,000 barrels per day. But regardless of size, the end result of Platforming is the same . . . the production of a blending component (Platformate) that improves the performance of the refiner's motor fuel.

This is what Platformate offers: Road octane ratings of nearly 100 (with the addition of lead) even when produced from the lowest quality naphthas; Inherent stability; Negligible sulfur content; Pleasant odor; Increased energy; And economy of production. Think of the importance of a blending component with these characteristics as applied to your own marketing operation.●

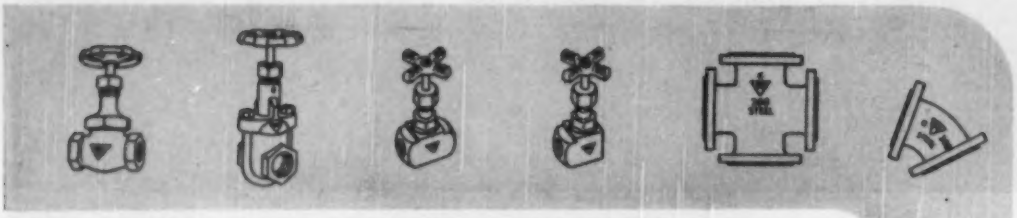
UNIVERSAL OIL PRODUCTS COMPANY

UOP

General Offices: 310 S. MICHIGAN AVE., CHICAGO, ILLINOIS, U.S.A.
LABORATORIES: RIVERSIDE, ILLINOIS

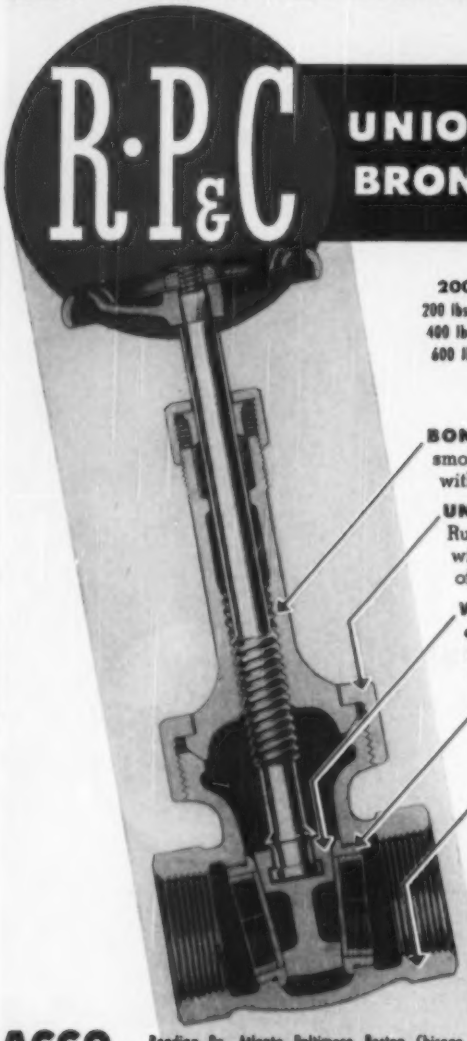
Universal Service Protects Your Refinery

NEW PLATFORMED GAS



ASK YOUR R·P&C DISTRIBUTOR ABOUT

R·P&C UNION BONNET BRONZE GATE VALVES



200 LB. CLASS	300 LB. CLASS
200 lbs. steam at 500°F.	300 lbs. steam at 550°F.
400 lbs. CWG (non-shock)	600 lbs. CWG (non-shock)
600 lbs. Hydrostatic Test	800 lbs. Hydrostatic Test

Integral Bronze Seats
Nickel Bronze Seat Rings

BONNET P & C High Test Bronze with smoothly machined bevel for tight joint with body.

UNION RINGS P & C Valve Bronze. Rugged. Permits repeated disassembly without distortion of body or weakening of threads.

WEDGE Nickel alloy. Reversible. Milled grooves engage guide ribs in body, reducing seat wear. With valve full open, wedge clears line of flow.

SEAT RINGS Nickel alloy (renewable in sizes 1" and larger) or bronze, integral with body.

BODY P & C High Test Bronze. Heavy end hexes. Heavy section and strong threads at union for long service.

● *Send* FOR YOUR COPY OF DH 191

ACCO

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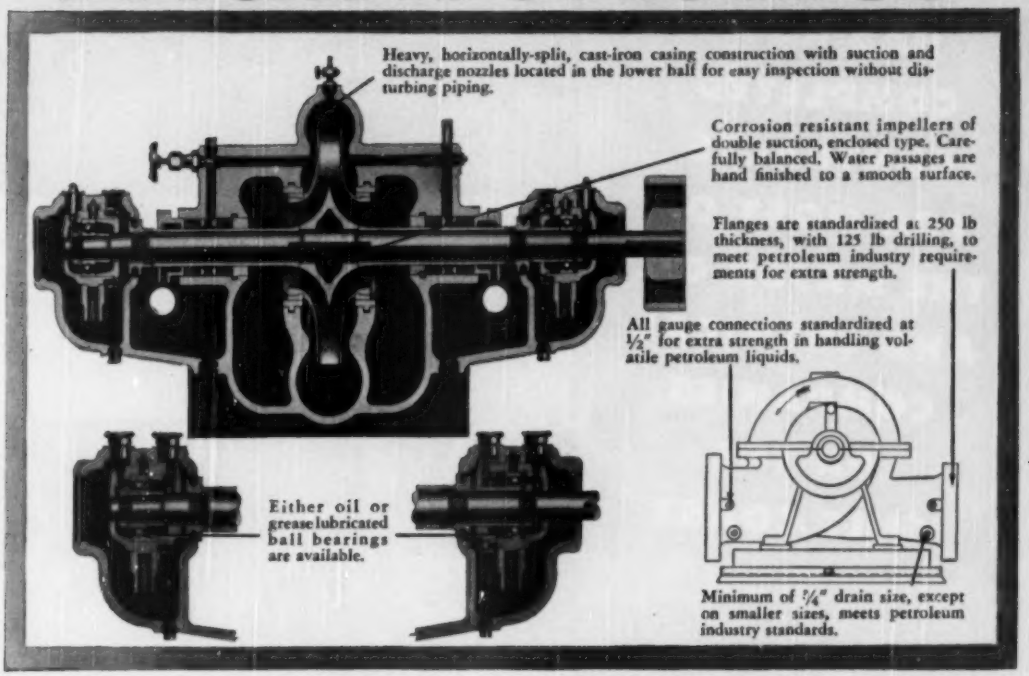
R-P & C VALVE DIVISION
AMERICAN CHAIN & CABLE

READING-PRATT & CADY VALVES

Designed for Low Maintenance


Heavy, horizontally-split, cast-iron casing construction with suction and discharge nozzles located in the lower half for easy inspection without disturbing piping.
Corrosion resistant impellers of double suction, enclosed type. Carefully balanced. Water passages are hand finished to a smooth surface.
Flanges are standardized at 250 lb thickness, with 125 lb drilling, to meet petroleum industry requirements for extra strength.
All gauge connections standardized at ½" for extra strength in handling volatile petroleum liquids.
Either oil or grease lubricated ball bearings are available.
Minimum of ¾" drain size, except on smaller sizes, meets petroleum industry standards.

THE DEMAND FOR LOW MAINTENANCE pumps for the petroleum industry has steadily increased. To serve this specific need, Allis-Chalmers offers a *complete* line of Type S, single stage, double suction pumps, individually engineered to meet your specifications.

All parts are precision machined and carefully assembled. Heavy construction plus proper alignment of pump parts assure long life of wearing rings, sleeves, packing and bearings. Impeller and shaft are carefully balanced. Impeller clearances are accurately measured to cut recirculation losses.

Although the most common drives for centrifugal pumps are Allis-Chalmers squirrel cage induction motors, Allis-Chalmers also supplies a complete line of induction, synchronous and direct current motors, and gasoline engines of the generally used sizes for most pumping applications.

For complete information on Allis-Chalmers pumps and drives, contact your nearby A-C Sales Office, or write direct for Bulletin 08B6146A.

A-3157

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MILWAUKEE, WIS.

ALLIS-CHALMERS

Texrope is an Allis-Chalmers trademark.

Power, Electrical, Processing Equipment for Petroleum Industry

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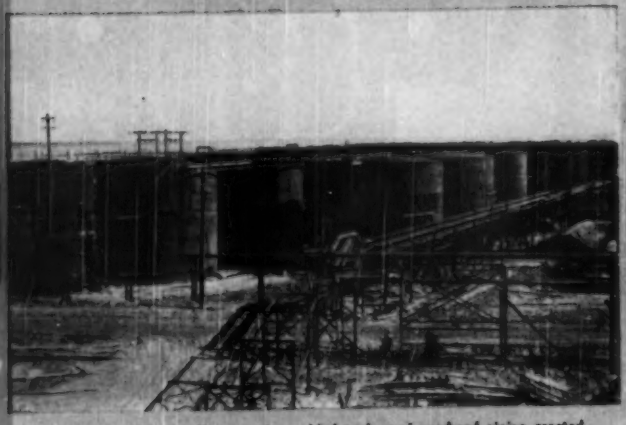
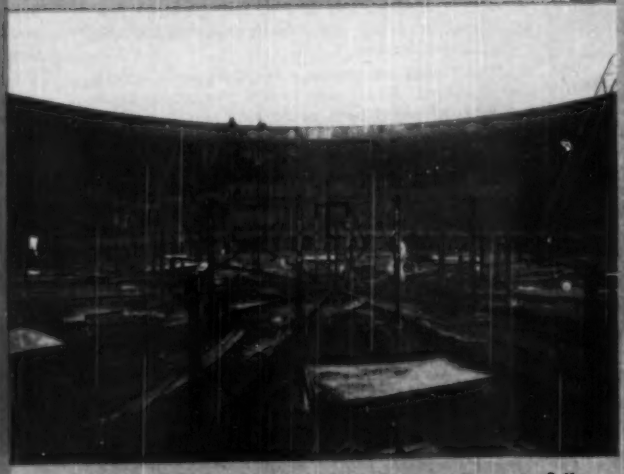
HAS NOW COMPLETED CONTRACTS FOR MOST OF THE MAJOR OIL AND CHEMICAL COMPANIES ON THE GULF COAST

One of our best recommendations is a list of the customers we keep! Ellerbee Brothers has now performed contracts for most of the major oil and chemical companies on the Gulf Coast. Repeat work has been done for many of these majors. We feel our success has resulted from the tested formula of experienced and capable personnel working with modern equipment under the personal supervision of men with as much as 20 years' experience who take personal pride in each job. We will appreciate an inquiry from you. Write today for the Ellerbee Brothers brochure.

Laying 20" diameter tank farm piping at Mid-Valley Pipe Line Company's Meyerville, Miss., station.



Part of the 103 miscellaneous size welded tanks and overhead piping erected under one contract for a large Gulf Coast Oil company



This 117' diameter pan type floating roof tank constructed for a major Gulf Coast refining company. Galvanized sheet are in foreground.

ELLERBEE BROTHERS

P. O. BOX 887 PORT ARTHUR, TEXAS

THERE'S A PETRO-CHEM ISO-FLOW FURNACE FOR EVERY CAPACITY, SERVICE AND DUTY

* LUBE OIL PLANT HEATERS

FOR Crude Distillation • Vacuum Distillation • Solution Rerunning
Raffinate Extraction • Asphalt and Deasphalting
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* GAS AND GASOLINE PLANT HEATERS

FOR Gas Dehydration and Reactivation • Reboiling
Heat Medium Circulating • Rich Oil • Diethylene Glycol

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FOR Light and Heavy Gas Oil Heating
Atmospheric and Vacuum Feed Preparation • Reforming

* CHEMICAL PLANT HEATERS

FOR Gas Cracking • Gas Synthesis
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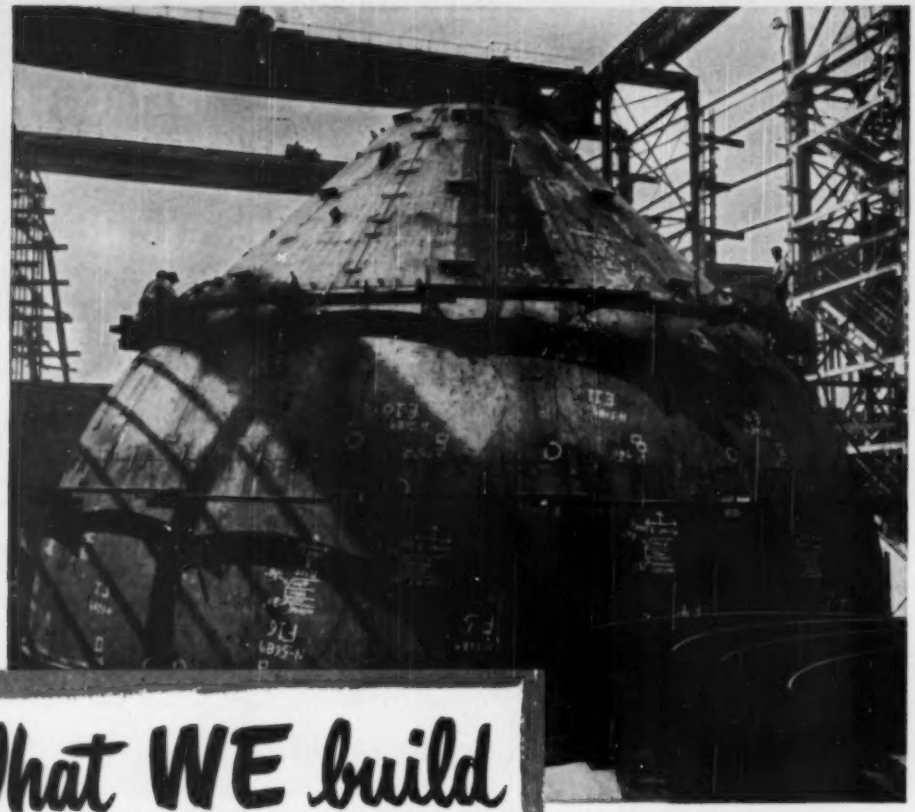
* FROM 1 TO 70 MILLION BTU'S WITH EFFICIENCIES UP TO 85%

YOU NAME YOUR PROCESS CONDITIONS and we'll tell you where there is a Petro-Chem Iso-Flow Furnace operating to meet your requirements . . . of the many hundreds now in successful operation, most Petro-Chem Iso-Flow* Furnaces operate beyond their design ratings.*

PETRO CHEM
ISO-FLOW FURNACES
PETRO-CHEM DEVELOPMENT CO., INCORPORATED



What WE build we build good

This is not a part of a ship or marine vessel, nor the nose of a huge torpedo. It is a section of a 55 foot diameter oil refining unit. It is being built in our plant where a large variety of similar equipment is built each year as regular products of this plant. Note the true shape and the accurate fits. Because of our vast facilities and long experience no job is too large and "what we build we build good."

Sun

SHIPBUILDING & DRY DOCK COMPANY

ON THE DELAWARE (SINCE 1916) CHESTER, PENNA.

25 BROADWAY • NEW YORK CITY

SENSITIVITY

VACUUM RELIEF
VACUUM
BACK PRESSURE
BOILER STEAM
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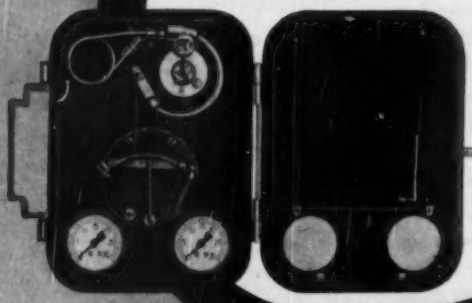
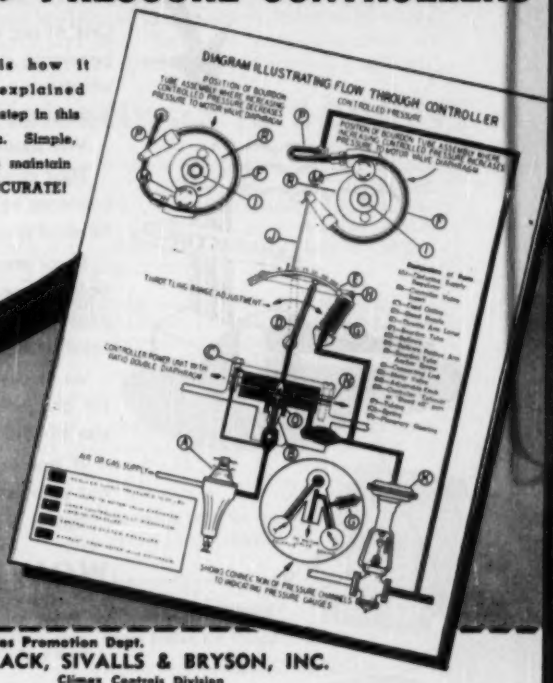
Type 1400 handles both positive and negative pressures, from high vacuum to 10,000 psi. It is adaptable to services requiring high sensitivity or to wide throttling ranges for dampening sensitivity. Overcomes hunting action which makes lined out pressure control difficult. Adjustable in the field for snap action. Bourdon-tube actuated.

BS&B

Climax TYPE 1400 PRESSURE CONTROLLERS



Here is how it works, explained step-by-step in this diagram. Simple, easy to maintain and ACCURATE!



Now you can be assured positive and sensitive response to pressure changes, with a controller characteristic usually obtained only in more expensive type recording instruments. Climax builds it right, for long service under all conditions. A multitude of special adaptations are possible... Ask your BS&B-Climax Man today!

You Can Count on Your Climax Man

His sound backlog of experience in process controls is available for your own use. He will be pleased to help you beat a tough problem. He is readily available, just check the coupon. Naturally, all inquiries are held in strictest confidence.

Sales Promotion Dept.
BLACK, SIVALLS & BRYSON, INC.
Climax Controls Division

Sec. C4-23-12 7500 E. 12th St. Kansas City 3, Mo.

I would like the complete story of the BS&B-Climax Type 1400 Pressure Controller . . . catalog, data, diagrams, prices. ☐ I want a Sales Engineer to call.

NAME_____

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STREET_____

CITY_____ STATE_____

We don't Sell Your Customers

WE CARRY TUBE TO YOU

WE CARRY TUBE TO YOU

YOU CARRY ON FROM HERE

YOU CARRY ON FROM HERE

One of our prospects (prior to becoming a customer) asked us whether we would sell tubing to him and also accept orders for tubing from *his* customers.

We shouted an emphatic "No!"

That question is often asked by those who select concerns to supply material as components of their finished products or for sale over their counters.

Over many years we have maintained a definite policy of *not* competing with our customers. We try to protect their interests for we sincerely appreciate the relationship we have with them.

As a customer, you can feel free to come to us for any help you need, knowing that your problems can be discussed with us in strict confidence.

If you're our customer, we like that. And we're not your competitor, so you like that.

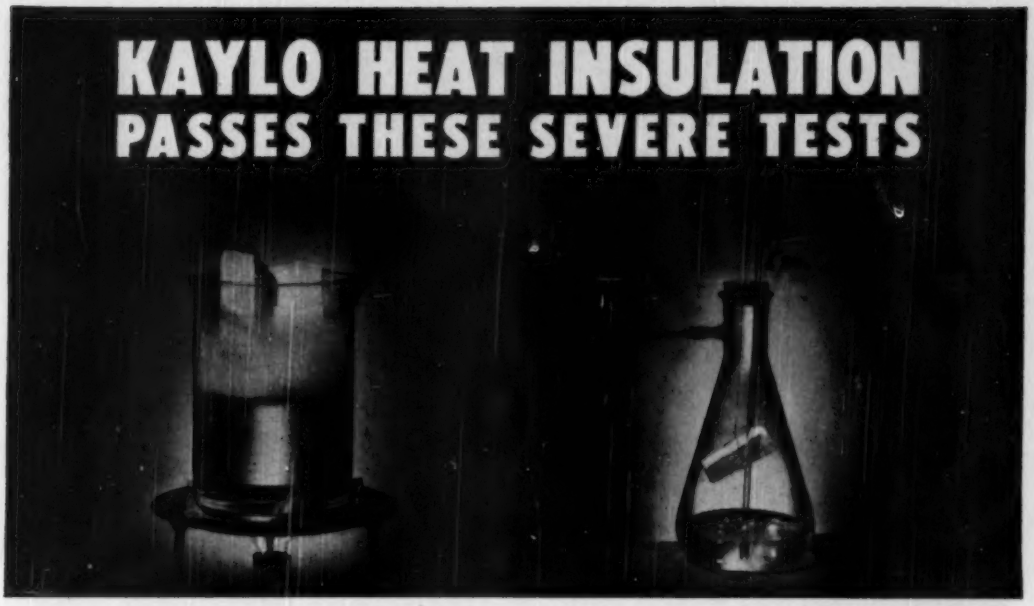
Let us be of help to you.

WOLVERINE TUBE DIVISION

Calumet & Hecla Consolidated Copper Company
INCORPORATED
MANUFACTURERS OF SEAMLESS, NON-FERROUS TUBING
1431 CENTRAL AVE. • DETROIT 9, MICHIGAN

PLANTS IN DETROIT AND DECATUR, ALA.
Sales Offices in Principal Cities

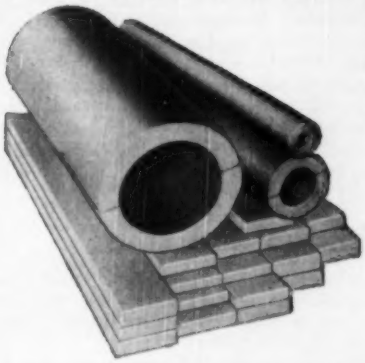
KAYLO HEAT INSULATION PASSES THESE SEVERE TESTS



BOILING TEST: Samples of Kaylo Heat Insulation have been boiled continuously for 24 hours and longer. None disintegrated or showed any loss of insulating efficiency after drying.

FUME TEST: Samples of Kaylo Heat Insulation were suspended in an aerated mixture of water vapor and SO_2. The Kaylo samples showed no deterioration after weeks of direct exposure.

One Material Insulates Efficiently up to 1200°F.



Kaylo Heat Insulation is made of hydrous calcium silicate (not glass), a remarkable material with high insulating efficiency up to 1200°F. This new type of inorganic insulating material retains its stability in long service under severe conditions. Exceptional strength and lighter weight make it easier to handle and apply.

KAYLO PIPE INSULATION is produced in Simplified Dimensional Standards of thicknesses and diameters for pipe sizes from ½" to 72". Coverings are sectional for sizes ½" to 12"; tri-segmental for 8" to 23"; quad-segmental for 19" to 41"; K-segmental (18" sections) for 38" to 72". O.D.'s of insulation correspond to O.D.'s of standard pipes.

KAYLO HEAT INSULATING BLOCK is available for single layer application in thicknesses from 1" to 6". It is made in all standard sizes up to 18" x 36".

KAYLO®

PIPE INSULATION AND HEAT INSULATING BLOCK

OWENS-ILLINOIS GLASS COMPANY
Kaylo Division • Toledo 1, Ohio

SALES OFFICES:
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SEND COUPON FOR KAYLO HEAT INSULATION LITERATURE

OWENS-ILLINOIS GLASS COMPANY
Dept. N-91, Kaylo Division • Toledo 1, Ohio

Gentlemen: Please send me descriptive literature on Kaylo Heat Insulation.

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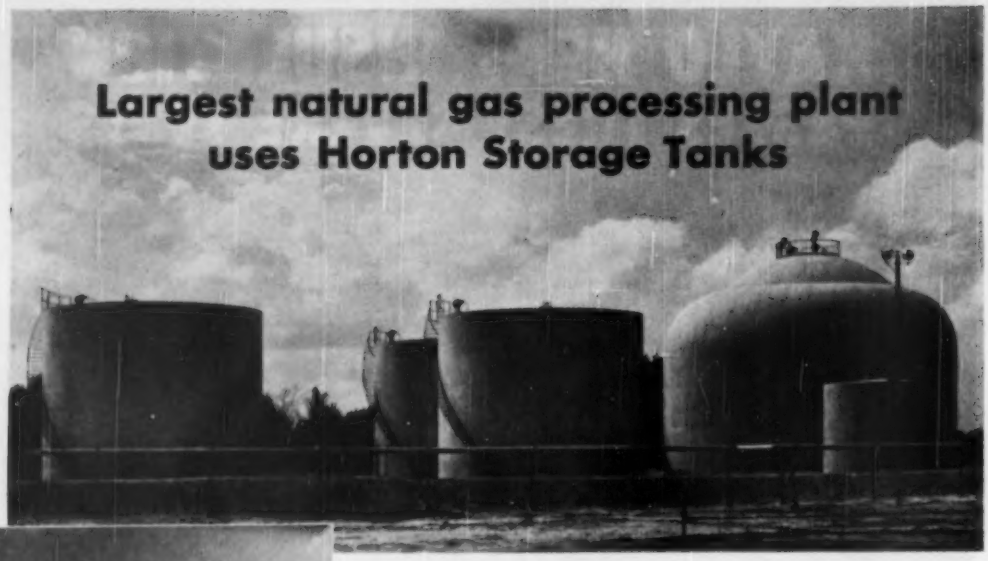
FIRM.....

ADDRESS.....

CITY.....STATE.....

Largest natural gas processing plant uses Horton Storage Tanks



The Carthage Corporation's new natural gasoline plant at Carthage, Texas, is the largest built to date for the delivery of dehydrated natural gas to transmission pipe lines. It has an absorption capacity of 385,000 M.c.f. daily. At this time, products recovered each day average 40,000 gallons of propane; 75,000 gallons of butanes; 5,500 bbls. of motor fuel; 560 bbls. of kerosene; and 150 bbls. of residuum.

The accompanying views show some of the storage tanks which we fabricated and erected at this efficient plant. The 5,000-bbl. cone-roof tanks shown above are used for storing naphtha, kerosene, and mineral seal oil; the 20,000-bbl. Hemispheroid at the right in the general view and at the left stores gasoline at 2½ lbs. per sq. in. working pressure; and the 1,000-bbls. cone-roof tank stores residuum.

Horton* flat-bottom storage tanks with cone-roofs are available in standard capacities from 500 to 268,000-bbls. or in special sizes to meet your requirements.

The Hemispheroid is built in capacities up to 30,000 bbls. for 2½ lbs. per sq. in. working pressure and up to 7,500 bbls. for 5 lbs. pressure. Get full details from our nearest office.

Some Facts about the Horton* Hemispheroid

The Horton Hemispheroid is used primarily for the storage of motor fuel, aviation gasoline, and the less volatile grades of natural gasoline. When storing volatile liquids like these under normal operating conditions, the Hemispheroid reduces filling losses and stops practically all breathing losses.

Special Horton* Tank Roofs

In addition to cone-roof or pressure storage tanks we also fabricate and erect tanks with Horton Floating Roofs and Horton Vapordome Roofs. These roofs are used to reduce evaporation losses from flat-bottom tanks storing volatile hydrocarbons.

Write our nearest office for complete information and quotation when you need storage tanks of any type. Please state number of tanks required, capacity, location and diameter and height if special dimensions are required.

**Trademark Registered in U. S. Patent Office.*

CHICAGO BRIDGE & IRON COMPANY

Plants in BIRMINGHAM, CHICAGO, SALT LAKE CITY and GREENVILLE, PENNSYLVANIA

Atlanta 3	2146 Healey Building	Detroit 26	1520 Lafayette Building	Philadelphia 3	1608—1700 Walnut Street Building
Birmingham 1	1548 North Fiftieth Street	Havana	402 Abreu Building	Salt Lake City 4	531 West 17th South Street
Boston 10	1030—201 Devonshire Street	Houston 2	2126 National Standard Building	San Francisco 4	1551—200 Bush Street
Chicago 4	2461 McCormick Building	Los Angeles 17	1534 General Petroleum Building	Seattle 1	1331 Henry Building
Cleveland 15	2234 Guildhall Building	New York 6	3302—165 Broadway Building	Tulsa 3	1626 Hunt Building

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Motherwell Bridge & Engineering Company, Limited, Motherwell, Scotland
Whessoe, Limited, Darlington, England
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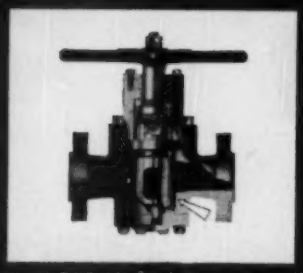
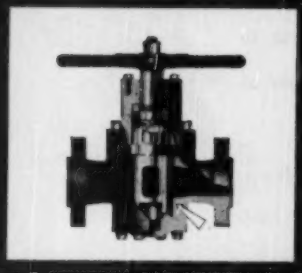
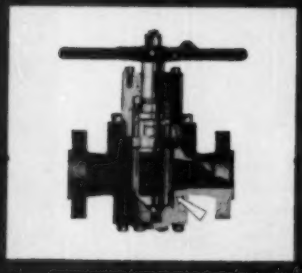
KEROTEST



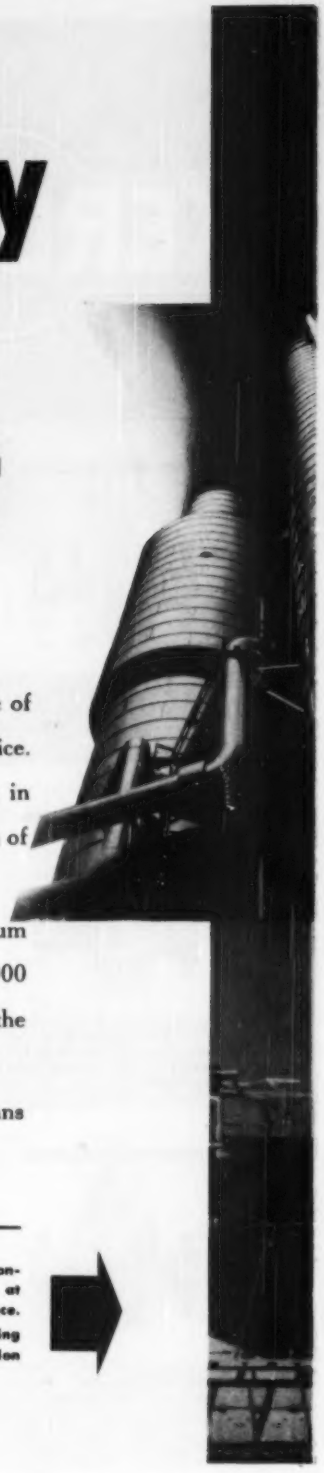




TWIN SEAL VALVE

KEROTEST MANUFACTURING CO.

Familiarity Breeds Content



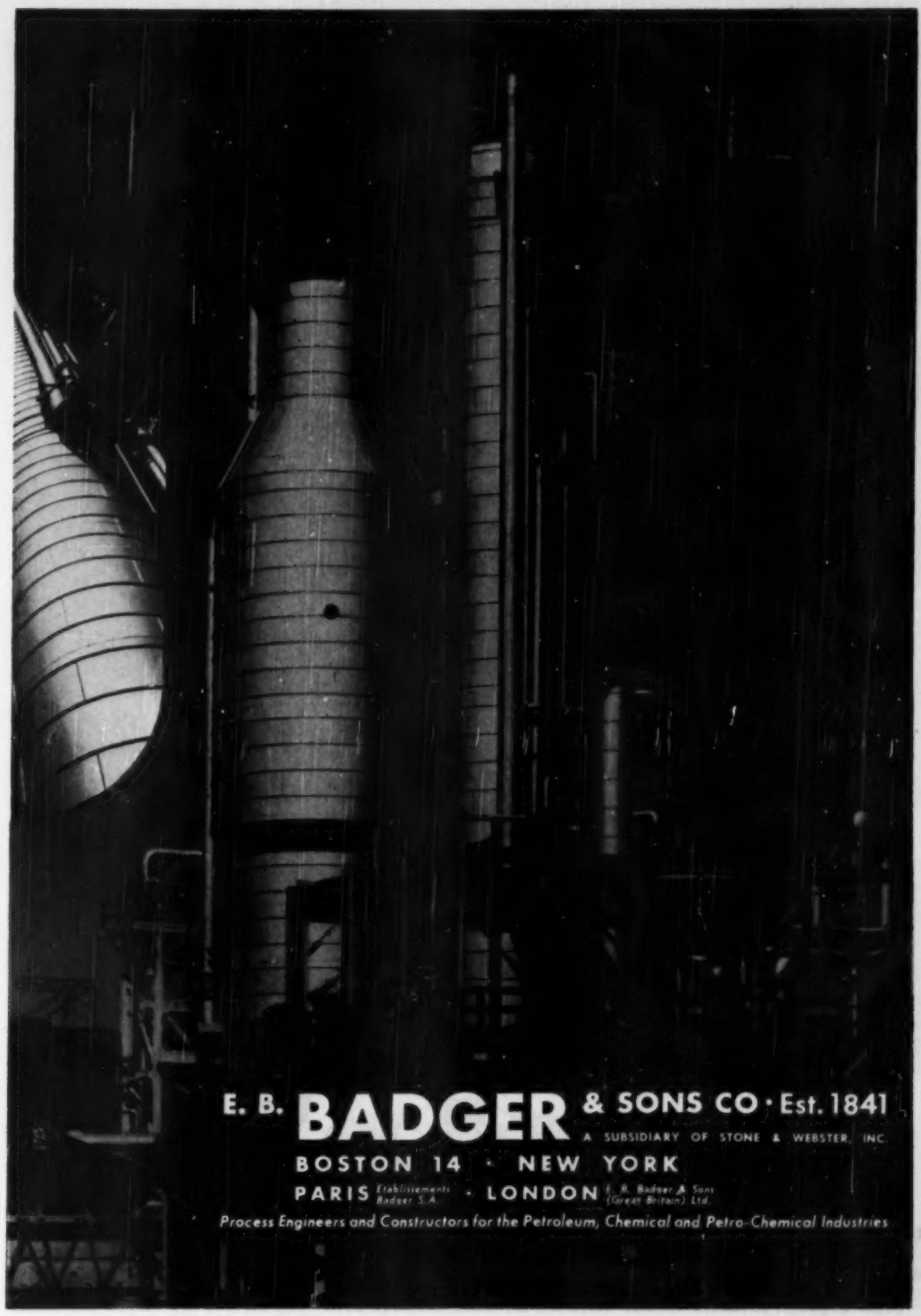
Badger has specialized knowledge of distillation principles and practice. This has been gained through decades of pioneering in process investigation and in the design and construction of hundreds of distillation units.

If all Badger-built distillation units were in the petroleum industry alone, their total capacity of over 190,000,000 gallons per day would be sufficient to distill 80% of the national crude run.

This broad familiarity in the field of distillation means successful plants and satisfied clients.

This 21,500 BPSD crude topping and distillation unit, engineered and constructed as part of a large program for Socony-Vacuum Oil Company, Inc. at Paulsboro, New Jersey, is a current example of Badger's distillation experience.

It is designed to handle a wide variety of light or heavy crudes, including those of high sulfur content. The entire unit has extreme flexibility in operation and incorporates extensive features for ease in maintenance.


E. B. BADGER & SONS CO · Est. 1841
A SUBSIDIARY OF STONE & WEBSTER, INC.
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Process Engineers and Constructors for the Petroleum, Chemical and Petro-Chemical Industries

Fight Corrosion

...WITH THIS RUGGED STUD

Tough—long-lasting—dependable—Republic Upson Alloy Steel Studs are a first line of defense against corrosion. In addition they have the great strength and staying power to stay "on stream" despite blistering temperatures and punishing pressures.

Precision-made—they also turn off as freely as they go on—when lines, heat exchangers and blowers must be opened.

Next time you have a stud failure from whatever cause—make your replacements Republic Upson Alloy Steel Studs and reduce future failures to a minimum. Likewise—next time the matter of new equipment is up for action, specify these studs and head off corrosion worries before they start!

REPUBLIC STEEL CORPORATION
BOLT & NUT DIVISION • CLEVELAND 13, OHIO
Export Department: Chrysler Building, New York 17, New York

REPUBLIC *Upson Quality* **ALLOY STEEL STUDS**

REPUBLIC STEEL

Made from Alloy Steel—from the furnaces of Republic, world's leading alloy steel producer.

Other Republic Products Include Machine, Tank and Carriage Bolts—Lag Screws, Cap Screws and Rivets

Another RIC-WIL INSTALLATION FOR YEARS OF TROUBLE-FREE TOP PERFORMANCE

"On-the-job" stockpile of Ric-wil Prefabricated Insulated Piping.

Partial view of Spencer Kellogg Plant showing storage elevators and expeller process plant, taken from the new solvent process extraction plant. Engineers for the new plant were Crosby Construction Co. of Chicago; contractors Moffett and Troop, Pittsburgh, Pennsylvania.

View showing oil tanks and pipe hanger supports for the new extraction plant.

RIC-WIL PREFABRICATED INSULATED PIPING SPEEDS UP INSTALLATION

The solvent extraction process used in the new Spencer Kellogg soy oil extraction plant at Decatur, Illinois, requires extensive piping systems for conveying cold and recirculated water, steam, condensate, soy oils, and solvents.

The use of Ric-wiL Prefabricated HEL-COR Piping for overhead lines speeded up installation and provided the system with maximum insulation and protection. Two 4-inch lines carrying soy oil and a steam tracer line for proper temperature control were nested in a solid insulation cylinder and housed in a 16-gauge ingot iron conduit, helically-corrugated and zinc galvanized. For additional corrosion resistance, outside of conduit was coated with high melting point asphalt and inside coated with baked-on phenolic resin.

All accessory piping units such as elbows, tees, and expansion loops were prefabricated by Ric-wiL, insuring simple, fast installation when they reached the job.

This installation is indicative of how Ric-wiL may solve your insulated piping problems. A Ric-wiL representative near you will give you complete information without cost or obligation, or if you prefer, write to The Ric-wiL Company, Dept. 6-TA, Cleveland, Ohio.

Crane assists in positioning Ric-wil Piping in elevated installation.

40 YEARS

Ric-wiL

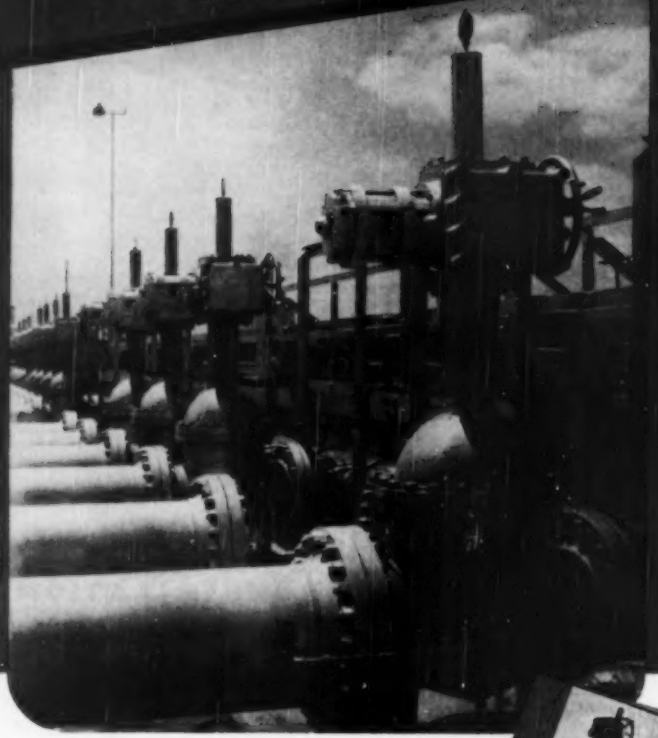
INSULATED PIPING SYSTEMS

OVERHEAD — THE RIC-WIL COMPANY · CLEVELAND, O. — UNDERGROUND

FOR FORTY YEARS THE GREATEST NAME IN INSULATED PIPING SYSTEMS

MAINTENANCE MAN NEEDED

...another LIMITORQUE Advantage



Just install 'em and forget 'em. LimiTorque Controls give dependable performance in Refinery and Pipe Line service without a maintenance man to nurse them along. They're fully lubricated when built . . . with grease, not oil . . . and will function for years without trouble. Operating parts are entirely mechanical . . . no servicing required. Manual or handwheel operation, provided for emergency service, is positive . . . no attention or check-ups are needed.

LimiTorque fits all types of valves and can be actuated by any available power source. Your valve manufacturer can furnish them.

Complete information is given in the LimiTorque Catalog . . . write for a copy on your Business Letterhead.

Philadelphia Gear Works, INC.

ERIE AVE. AND G ST., PHILADELPHIA 34, PA.

NEW YORK • PITTSBURGH • CHICAGO • HOUSTON

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Industrial Gears and Speed Reducers
LimiTorque Valve Controls

GARLOCK MECHANICAL SEALS FOR *Rotary Shafts*

Where leakless operation of rotary shafts on pumps or other equipment is required, GARLOCK MECHANICAL SEALS will do the job.

There is no wear on the shaft when a Garlock seal is used. Sealing is effected by leakless and positive contact between carefully lapped metal-to-carbon or metal-to-metal mating surfaces. One of these elements rotates with the shaft and the other is stationary. The stationary element does not contact the shaft.

These precision-built seals are made in several standard designs and in a wide range of highest grade materials. The selection of design and materials depends upon the service in which the seal is to be used. If none of our standard designs appears entirely suitable for any specific application, a modification of a standard design or a specially designed seal will be engineered and built for that job.

Thousands of GARLOCK MECHANICAL SEALS have proved their effectiveness, durability and economy on shafts operating at high and low speeds and pressures. Users of Garlock seals are enjoying many months—or years—of trouble-free operation on equipment handling various liquids such as, for example, water, gasoline, beer, acids and paint.

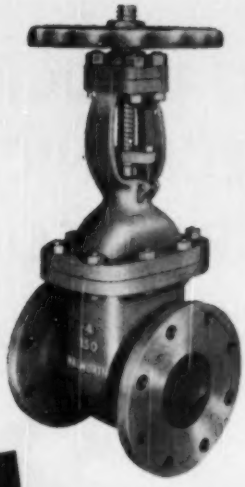
If you need Mechanical Seals for any kind of a rotary shaft application, let Garlock's experienced engineering staff work with you. Write for our Mechanical Seal booklet.

THE GARLOCK PACKING COMPANY
PALMYRA, NEW YORK

Tulsa, Okla. Houston, Tex.
Los Angeles, Calif.

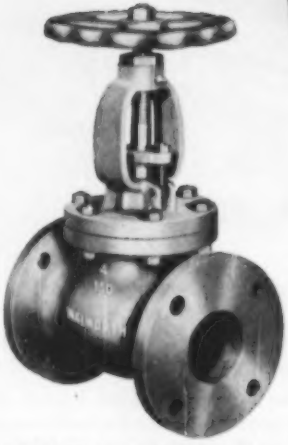
GARLOCK

Newly Designed Walworth Valves to combat corrosion



Walworth 150-pound Stainless Steel Gate Valve . . . available in sizes ½ to 3-inch, screwed; ½ to 12-inch, flanged.

Made of Stainless Steel
Monel · Nickel
Acid-resisting Bronze
Ni-resist



Walworth 150-pound Stainless Steel Globe Valve . . . available in sizes ½ to 3-inch, screwed; ½ to 6-inch, flanged.

Sectional view of Walworth 300-pound Stainless Steel Gate Valve . . . available in sizes 2 to 6-inch, flanged.

— ENGINEERED AND TESTED FOR TOUGH . . . HARD SERVICE

Walworth offers a comprehensive line of valves made of several cast stainless steels and special alloys for piping services where corrosion is a factor. These valves are available in Gate, Globe, Angle, Check, and Lubricated Plug types.

Gate, Globe and Angle Valves have outside screw and yoke construction, thus keeping the stem threads out of contact with the corrosive material in the line. They also have a two-piece bolted gland with ball-type gland follower to prevent binding the stem when packing bolts are tightened. Gland eye-bolts can be conveniently swung out of the way without danger of loss when the gland is lifted for repacking.

Gate Valves have taper seats with a unit consisting of two flat faced discs supported by a carrier on the end of the stem. The discs are of a proven ball-and-socket type. They are free to rotate and adjust themselves to the body seat angles, assuring tight seating with no possibility of sticking in any position.

For further information about Walworth's full line of corrosion-resistant valves, see your Walworth distributor.

WALWORTH

valves and fittings

60 EAST 42nd STREET, NEW YORK 17, N. Y.

DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD

ALL OVER THE WORLD REGARDLESS OF PROCESS

TYPE 3600

KEY REFINERY FITTINGS

INCREASE OPERATING EFFICIENCY

KEY Leadership is backed by

Research

Engineering

Service

The first return bend ever installed on an oil still was designed and manufactured by the Key Company. Ever since that first installation, research and development have been a large part of the program aimed at improving the quality of the products in the interest of the customers.

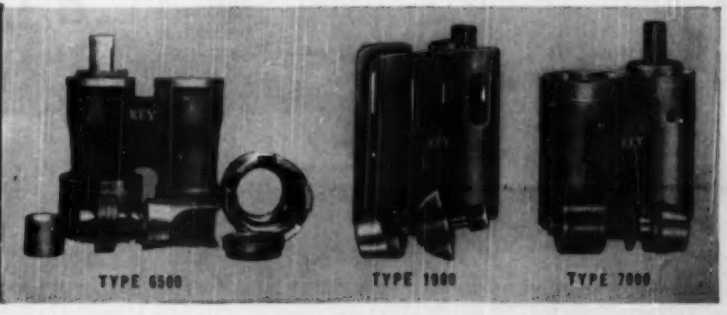
Key Fittings are engineered and designed by its own Engineers for each set of working conditions. In addition to this, all field men are trained Engineers.

After manufacturing and delivery — work for you has just begun. Key Field Engineers live with your fittings until retirement. The Key Company offers supervision on installation — maintenance assistance — and is the only manufacturer in the field to encourage and sponsor reconditioning service in the interest of the oil refineries.

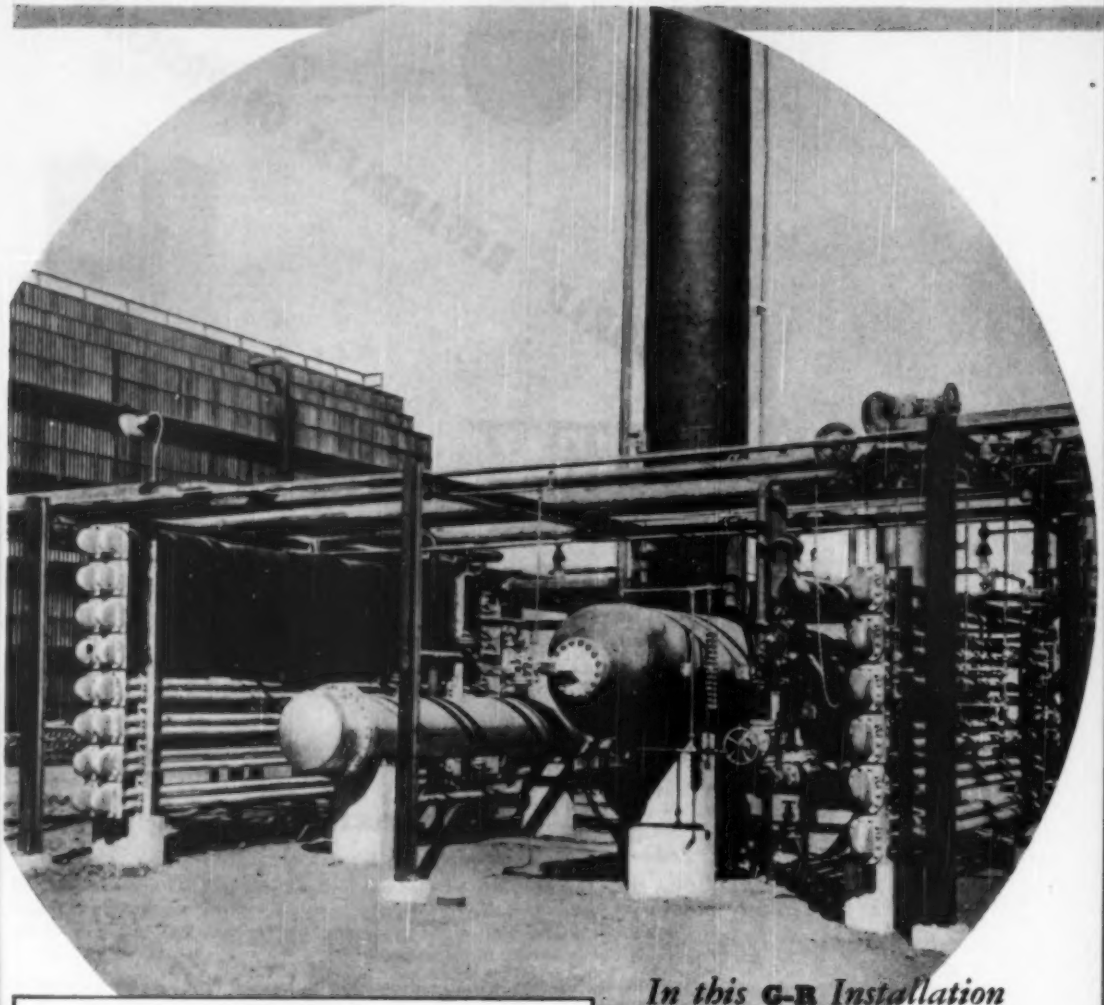
Write, Wire or Phone for Complete Details

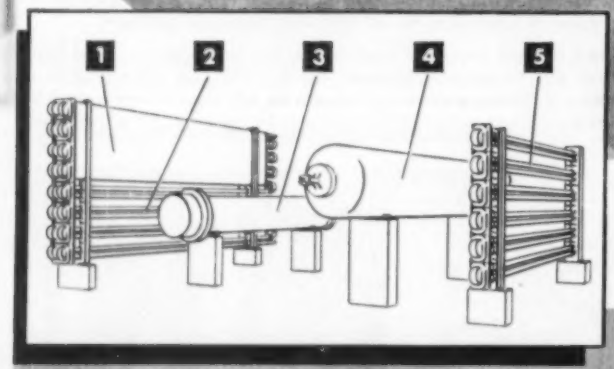
KEY COMPANY

East St. Louis, Illinois



TYPE 6500 TYPE 1900 TYPE 7000





In this G-R *Installation*

1. 8 G-R Twin G-Fin Sections, serving as Stabilizer Exchanger
2. 8 G-R Twin G-Fin Sections, serving as Stabilizer Cooler
3. G-R Type FLT Tubular Stabilizer Condenser
4. G-R Type FSE Stabilizer Reboiler
5. 6 G-R Twin G-Fin Sections, serving as Naphtha Side-Cut Cooler

GRISCOM-RUSSELL · PIONEERS IN HEAT TRANSFER APPARATUS

G-R

HEAT TRANSFER APPARATUS Fully Serves a Stabilizer In This Installation

As shown in the illustration on the adjoining page, all the heat transfer apparatus required for the stabilizer at this representative refinery is of G-R design. The G-R units include cooler, exchanger, reboiler and condenser, and also naphtha side-cut cooler.

Many additional G-R units, not shown in the illustration, were also installed for other services here; for this refinery, like hundreds all over the country, standardized on G-R Heat Transfer Apparatus to assure most effective heat exchange and recovery throughout the plant.

Whatever may be *your* heat transfer requirements . . . whether standard or special . . . investigate G-R designs. The unequalled range of G-R apparatus, including both finned tube and bare tube heat transfer surfaces, provides an exactly suitable design for every service. Write for descriptive bulletins on units for services in which you are interested.

THE GRISCOM-RUSSELL CO.
285 MADISON AVE., NEW YORK 17, N. Y.

TYPICAL DESIGNS OF G-R HEAT TRANSFER APPARATUS

G-R Tubular Exchanger, available with many different designs of stationary and floating heads, and with exclusive service features

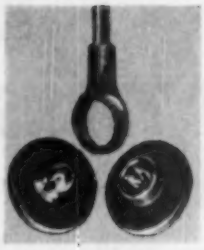
Sectional drawing of the G-R Twin G-Fin Section, the heat exchanger with a greater range of applications than any other design on the market

One of the designs of G-R Reboiler, available with bare tubes or K-Fin elements.

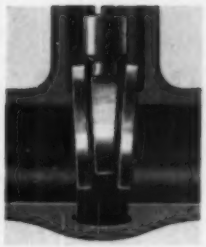
GRISCOM-RUSSELL

ALOYCO sets the STANDARD

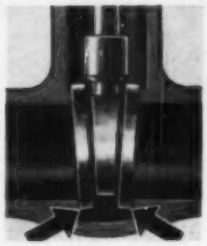
ALOYCO GATE VALVE, No. 111, 150 lb., Flanged, F and D. Sizes ½" to 12".



Those 3 sturdy parts comprise the Aloyco Double-Disc Ball-and-Socket Wedge.



The floating discs are free to rotate and thus wear evenly.



Wedge ring forces discs against seat, sealing ports with double valve effect. If one disc should leak, the other would still maintain closure.

When you install Aloyco Corrosion-Resistant Valves, their exceptionally long "life expectancy" makes substantial savings in your operating costs.

Aloyco durability is due to the painstaking development of the best practice in every step of the manufacture of these valves—from the drafting room clear through to the test bench. Even after years of service they operate freely and positively without external aids in the most severe applications.

Take the No. 111 Gate Valve, for example. This valve with its remarkable split wedge construction has been imitated widely, but never equalled outside of the Aloyco shops. Its excellent workmanship in every detail is typical of all Aloyco Valves.

Aloyco valves are furnished in Aloyco 20, 18-8S, 18-8SMO, Monel, Nickel and other alloys. They are manufactured in compliance with the new MSS Stainless Steel Valve Standards.

Aloyco service is nation-wide. Field engineers, backed by complete metallurgical and engineering staffs, are available to assist you in the selection of the best valve and alloy to suit your requirements. This service is yours for the asking.

ALLOY STEEL PRODUCTS CO., Inc.

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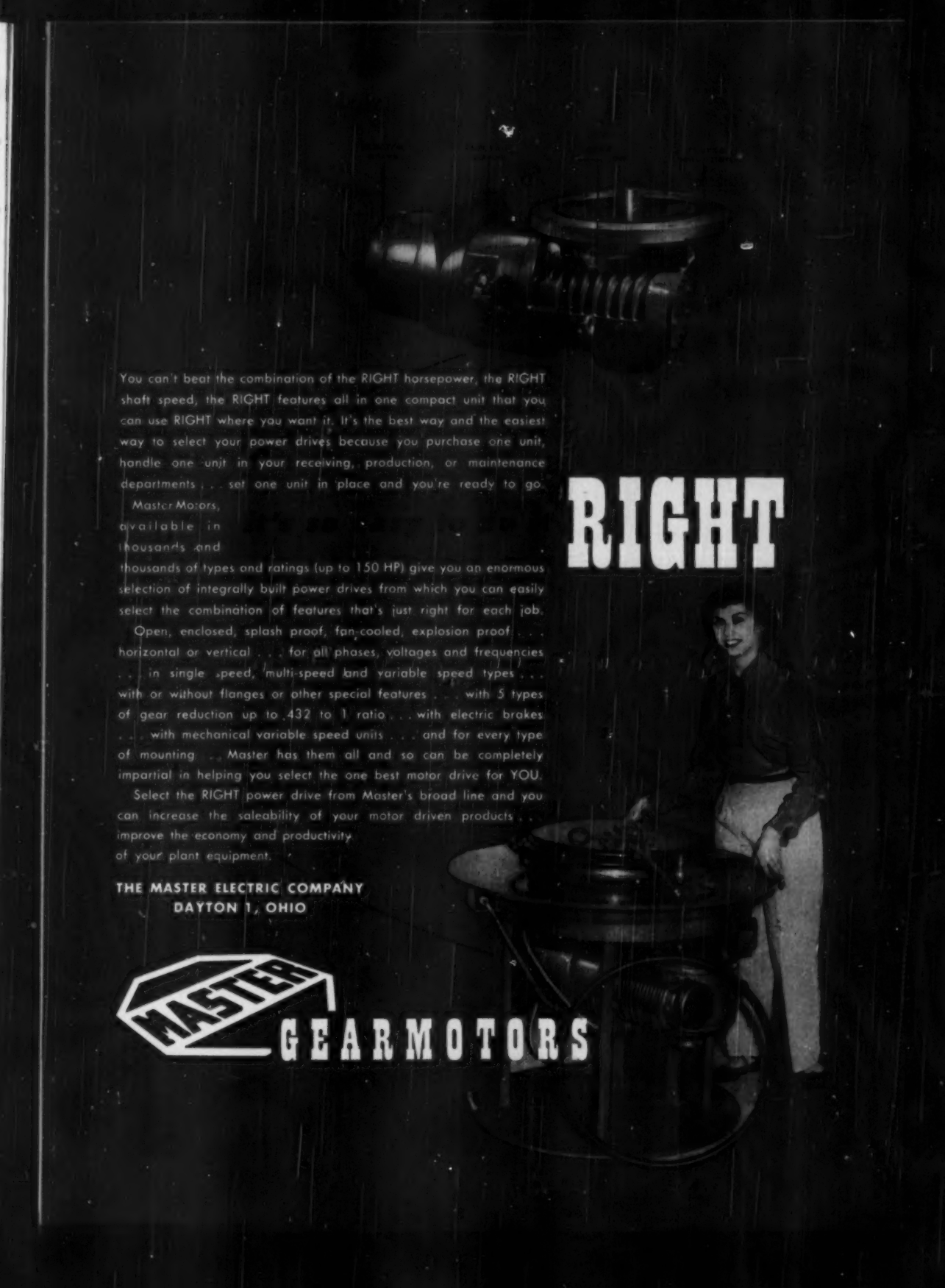

You can't beat the combination of the RIGHT horsepower, the RIGHT shaft speed, the RIGHT features all in one compact unit that you can use RIGHT where you want it. It's the best way and the easiest way to select your power drives because you purchase one unit, handle one unit in your receiving, production, or maintenance departments . . . set one unit in place and you're ready to go.

Master Motors, available in thousands and thousands of types and ratings (up to 150 HP) give you an enormous selection of integrally built power drives from which you can easily select the combination of features that's just right for each job.

Open, enclosed, splash proof, fan-cooled, explosion proof . . . horizontal or vertical . . . for all phases, voltages and frequencies . . . in single speed, multi-speed and variable speed types . . . with or without flanges or other special features . . . with 5 types of gear reduction up to .432 to 1 ratio . . . with electric brakes . . . with mechanical variable speed units . . . and for every type of mounting . . Master has them all and so can be completely impartial in helping you select the one best motor drive for YOU.

Select the RIGHT power drive from Master's broad line and you can increase the saleability of your motor driven products . . . improve the economy and productivity of your plant equipment.

THE MASTER ELECTRIC COMPANY
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THE price paid for Attapulgus and Porocel adsorbents is around *one cent* per pound—a fact which, we will agree, makes pretty dull reading. But for refiners using our materials, this modest investment pyramids to phenomenal returns. To be specific, each pound properly applied to petroleum stocks increases their value by at least *one dollar*—a return of 100 to 1.

Some four billion pounds of fullers earth and bauxite have been shipped to refineries by Attapulgus and Porocel—a noteworthy record of service to the industry. But what is even *more* noteworthy is the fact these materials have put four billion dollars into refinery purses—a point which makes *good* reading.

That's the record to date. It was accomplished by adsorbent-treating a wide variety of hydrocarbons to effect reduction or removal of colors, odors, tastes, moisture, sulfur, acids, fluorides and unsaturates, and for catalytic purposes. It's a record for *you* to tie to when considering plans to improve quality, expand output, or both.

Consult with us freely. Our broad knowledge of the behavior of our products under many sets of conditions should go far in helping *you* get 100 for 1.

ATTAPULGUS CLAY COMPANY *Fullers Earth* **· POROCEL CORPORATION** *Activated Bauxites*

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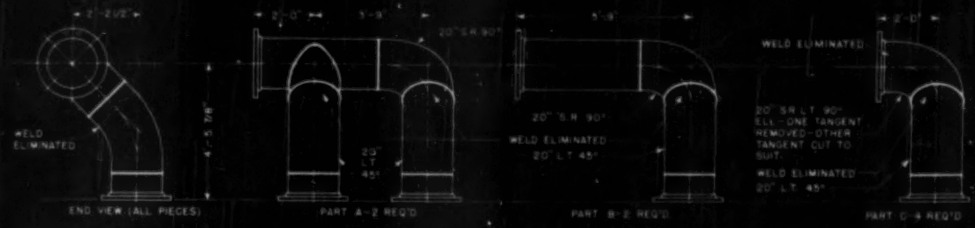
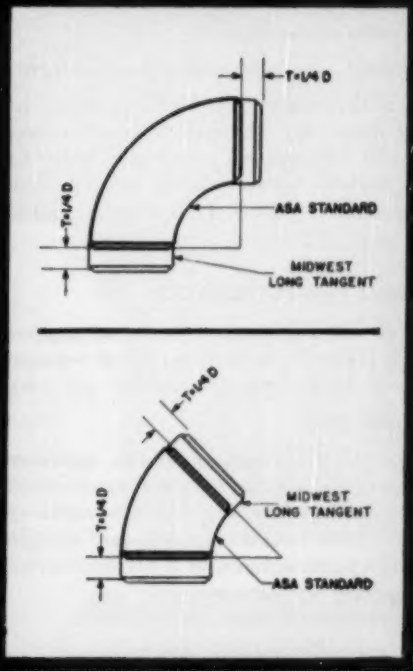
COST REDUCTION.



MIDWEST



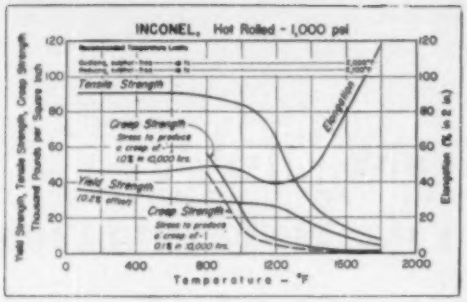
MIDWEST WELDING FITTINGS
Improve Piping Designs and Reduce Costs

INCONEL . . . the ECONOMY metal for HIGH-TEMPERATURE chemical processing

1. HIGH STRENGTH

2. OXIDATION RESISTANCE

3. RESISTANCE to CHEMICAL ATTACK



INCONEL IS STRONG

Strength, especially *hot-strength*, is the quality designers look for first in metals to be used in high-temperature applications.

INCONEL* *has exceptionally high hot-strength.*

In the heat-treating field, where equipment is constantly exposed to red-heat temperatures, INCONEL has repeatedly set long-time performance records. One fixture made of INCONEL carried full work loads for 13,000 consecutive hours at operating temperatures of 1600° to 2150° F.

INCONEL RESISTS OXIDATION

A metal may resist oxidation at normal temperatures ... but will it resist oxidation at the high temperatures necessary in processes like natural gas cracking?

INCONEL *will!*

Here's proof: In high-temperature enamel-setting furnaces where oxidation spalling of fixtures cannot be tolerated for fear of ruining expensive finishes – you'll find INCONEL hanger bars standard equipment. INCONEL's tightly-adhering oxide film does not scale to cause product contamination.

INCONEL RESISTS CORROSION

Where atmospheres are sulfur-free, INCONEL has a plant-proved performance record in successfully handling hot corrosive chemicals such as fatty acids, molten salts, burning gases, sintered metals, ore reductions, and certain organic chemicals at elevated temperatures.

INCONEL IS ECONOMICAL

INCONEL costs less than you would probably expect. In addition, INCONEL's superior service life and low maintenance requirements often result in outstanding long-run economies.

For economy *plus* serviceability ... *choose* INCONEL. INCO's Technical Service will gladly help with your specific problems. Your inquiries are always welcome!

*Reg. U. S. Pat. Off.

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INCONEL*... for long life at high temperatures

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TOWER COMBINATIONS

FROM 258
PREFABRICATED
PARTS

why Fluor can give you

THE RIGHT TOWER...
AT THE RIGHT TIME...
AT LESS ERECTION COST

Whatever your cooling problem—process, gas or liquid—Fluor has the cell size and height to meet flexibility and operating requirements. From only 258 standard interchangeable prefabricated parts, over 250 *different* tower sizes and arrangements are possible—the result of over 30 years' experience in the design and manufacture of cooling towers to solve virtually every cooling problem in industries utilizing water as a cooling medium.

Fluor is the largest manufacturer of prefabricated cooling tower parts in the world—Here's what this means to you . . .

THE RIGHT TOWER, *guaranteed* to meet your specified requirements. The octagonal shape, true counter-flow design and "Spirodome" upspray distribution system of a Fluor Counterflo Cooling Tower offer greater cooling capacity per square foot of ground area than any other type tower available!

AT THE RIGHT TIME means just that. From an in-stock supply of prefabricated parts, the tower meeting specified requirements can be "packaged" for immediate shipment. Your tower delivered this way gets fast freight handling and erection upon arrival.

AT LESS ERECTION COST because all parts are marked for fast erection. There's no need for trial-and-error or cut-and-fit erection methods. Another saving is realized by the elimination of scaffolding. Extra heavy grid decking supported on 2" x 4" cross bracing—a feature of all Fluor Counterflo Cooling Towers—form the only scaffolding necessary for continuous erection.

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"Cooling Tower Maintenance"

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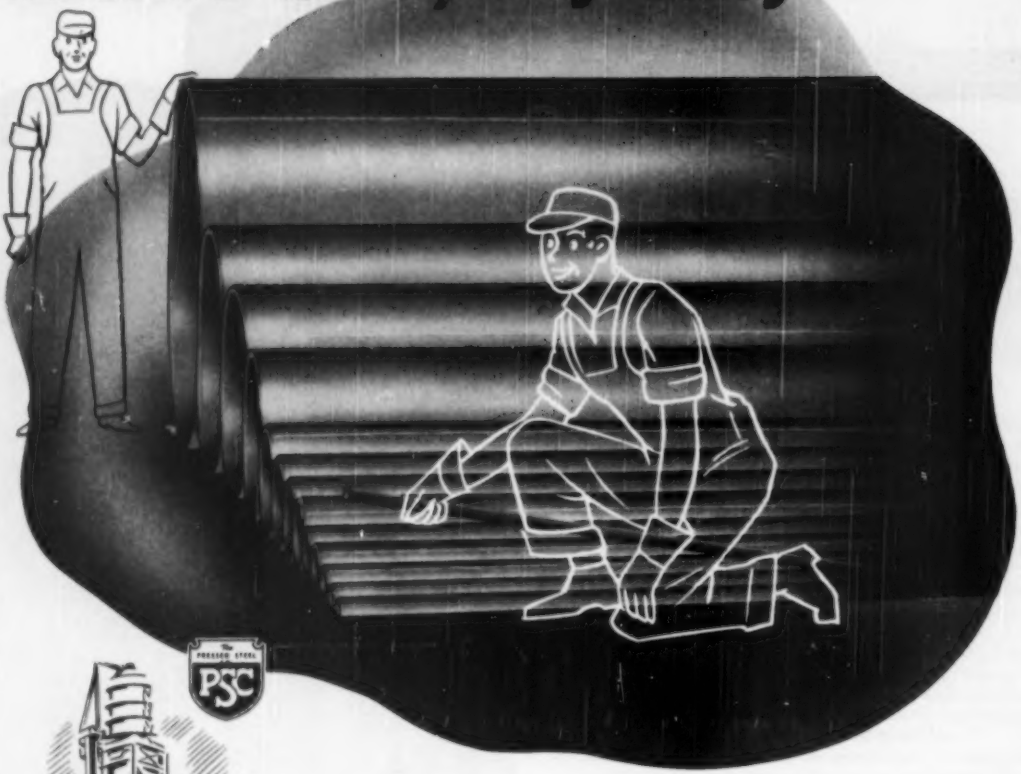
PSC REFINERY TUBES
in *ANY SIZE*, any alloy



PSC tubes are furnished in any diameter up to 60"; likewise in any alloy whatsoever. This unlimited range of PSC welded alloy tubes accounts for their wide application in meeting the unlimited variety of heat, corrosion and oxidation conditions experienced in refineries.

ANY SHAPE or DIAMETER UP TO 60"

PSC welded alloy tubes are in use in every important refining area. They are furnished for catalytic, polymerization and other processes, in any of the complete range of stainless and heat-resisting steels. Tubes for heat exchangers, pyrometer protection, acid resistance, etc. In any wall thickness up to 3/8"; temperatures to 2200°; butt-welded to make any required length. We also offer a wealth of experience in the precision fabrication of tubing assemblies to your designs. Write as to your needs, or for address of your PSC representative.

WALL THICKNESS	MIN'M O. D.
1/16"	.840"
1/8"	1.050"
3/16"	1.900"
1/4"	2.875"
5/16"	8.625"
3/8"	10.750"

PSC EQUIPMENT IS "ALLOY RIGHT"

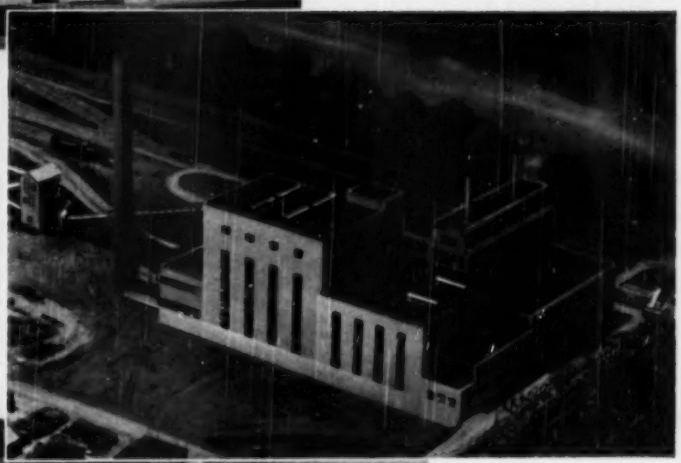
THE PRESSED STEEL COMPANY
of WILKES-BARRE, PENNSYLVANIA

Industrial Equipment of Heat and Corrosion Resistant WEIGHT-SAVING *Sheet Alloys*

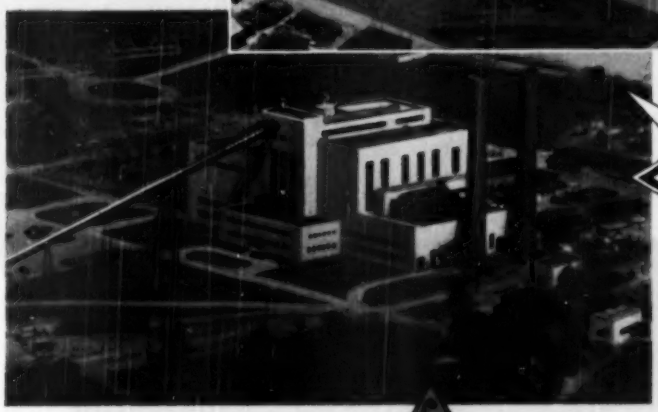
☆ ☆ ☆ OFFICES IN PRINCIPAL CITIES ☆ ☆ ☆

WITH THE NEED CAME THE POWER

Virginia Electric and Power Company instituted an expansion program in 1944 to more than double their electric generating capacity. These new power stations and extensions, three of which are illustrated here, are outstanding examples of efficient design for consistently reliable year-in, year-out, high-capacity performance. Facilities for this program, completed and in process of completion, will produce a total of approximately one-half million kilowatts. Design and construction are by Stone & Webster Engineering Corporation.



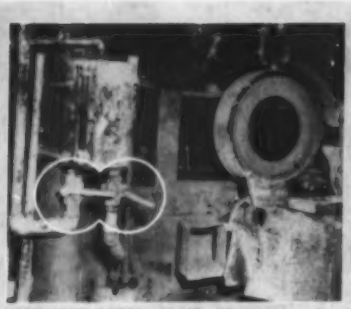
1. *Chesterfield Power Station, first with an installed rated capacity of 50,000 kw, has been extended with an additional installed rated capacity of 60,000 kw.*
2. *Recently completed Bremo Power Station extension, 60,000 kw rated capacity.*
3. *Possum Point Power Station where an extension of 60,000 kw rated capacity is under construction.*



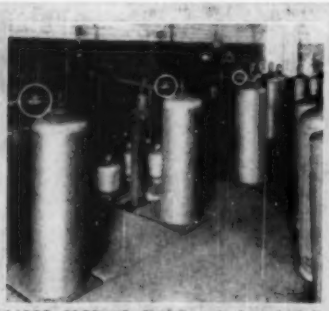
VEPCo

STONE & WEBSTER ENGINEERING CORPORATION

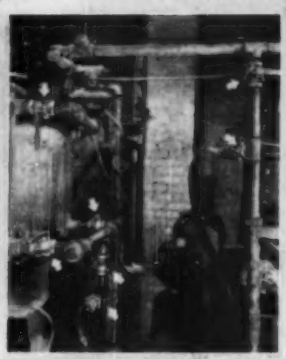
A SUBSIDIARY OF STONE & WEBSTER, INC.



LIBBEY-OWENS-FORD GLASS COMPANY — Two 1½" Rockwood Ball Valves operated 350,000 times with no maintenance. Used on river water to mix plaster for the grinding and polishing line. Valves are operated 1500 times a day. Only valve to stay in service over a year.



LARGE PROPANE PLANT — Rockwood Ball Valves have increased production by cutting down time and labor. Each valve is opened and closed every two minutes and between 300 and 400 tanks are shipped out daily. No maintenance.



IROQUOIS CHINA COMPANY, SOLVAY, NEW YORK — Foreman says "Rockwood Ball Valves are operated 40 times a day handling a mixture of clay and water. Each valve has performed better, operated easier and lasted longer than any other valve we ever used."

5 OUTSTANDING EXAMPLES—

PROVE ROCKWOOD BALL VALVES "OUT-PERFORM" THEM ALL

FULL ROUND FLOW
LEAK PROOF SERVICE
QUICK OPENING AND CLOSING

Here are actual Rockwood Ball Valve installation pictures.

Rockwood Ball Valves have already made, in various types of industries, an outstanding record for longer, dependable, efficient performance.

Three chief reasons for the amazing Rockwood Valve record is the leak proof service, full round flow, and quick opening and closing. These remarkable engineering features will give efficient and economical operation through years of everyday use. Together, they help increase your profits and reduce your maintenance cost.

Rockwood Ball Valves are giving outstanding service in chemical, food, paper, textile and other process plants, oil refineries and many other types of industries. Available in all pipe sizes from ½" to 4", for 300 p.s.i. working pressure.

Write for illustrated folder V-4.
Distributors in all principal cities.

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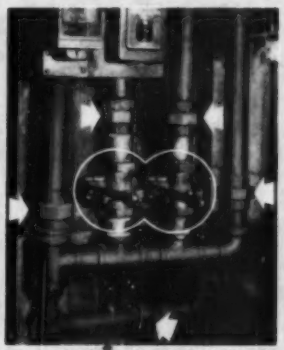
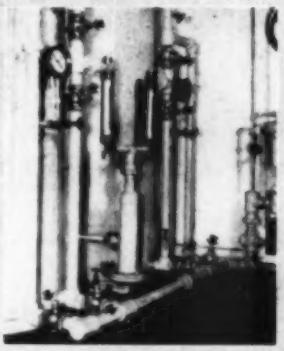


REVERE COPPER and BRASS INCORPORATED — Rockwood Ball Valves on quenching lines for annealing furnaces are operated 60 times a day under 100 p.s.i. Unfiltered river water flows thru the valves. Both valves have lasted 4 times longer than any other make of valves. Note Rockwood cold forged steel unions.



GASOLINE LINES ON "SWEETENING TOWERS" — Maintenance Engineer of this large gas company says, "The full round flow, leak proof service, easy operation and no maintenance cost make Rockwood Valves far ahead of any competitive valve we have used."

WeldELLS®

Whatever you seek on that next welded piping job...*speed*...*economy*...piping for *extreme conditions*...piping to withstand *corrosion*...you will find the answer to it in piping welded the WeldELL way.

You will find the answer because the WeldELL line incorporates job-speeding, cost-cutting features that are combined in no other welding fitting.

You will find the answer because the WeldELL line expresses the best of all we have learned in fifty years of intensive specialization in forged fittings for designed piping and pressure vessels.

The WeldELL line also goes beyond all others in range of sizes, types, thicknesses and scope of materials. Form a good habit—the WeldELL habit. Your reward will be the deep-down satisfaction of using the best there is! Coupon brings catalog.

Taylor Spiral Pipe is available in a broad range of sizes and thicknesses. Coupon brings Spiral Pipe Bulletin 493.

TF

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HEAT Stays *IN*side *THE* BORN "Upflo" Heater!!!

Designed to hold heat radiation to a minimum —the BORN "Upflo" keeps the heat where it can do the most "work." The special "plenum chamber," originated by BORN actually pre-heats the outside air, thus effecting most efficient operation, and at lower fuel cost.

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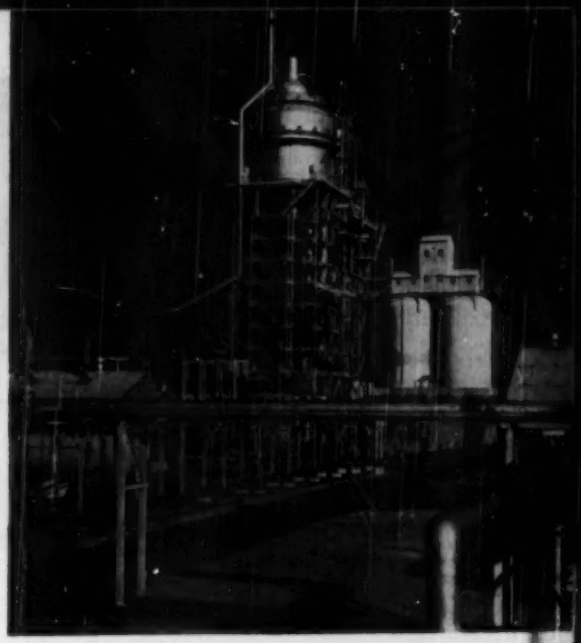
The LOOK BOX



THERE has been a lot of talk and little information about atomic power development in this country. Lawrence R. Hafsted, of the Atomic Energy Commission, varied somewhat from the usual pattern in a recent address before the API in Los Angeles. His report deals with trends, and possibly explains the status of atomic energy work as clearly as outsiders can expect in view of current security problems.

Nuclear Power Resources Committed

Hafsted stated that the development conducted by the Atomic Energy Commission involves two main categories of problems—technical and economic. Technical problems have received the bulk of attention to date. Nuclear reactors are machines for converting the energy available from chain reactions into useful forms. They provide, in effect, a slowed down and controlled atom bomb explosion.

The specific reactor projects under the present program are four in number:

1) A materials testing reactor, designed for the highest neutron flux yet attempted. Construction is well advanced.

2) A ship propulsion reactor which is to be a land-based prototype of a reactor for propelling submarines. Construction is well under way.

3) An experimental breeder reactor designed primarily to explore the possibilities of producing more fissionable material than is consumed. Construction and fabrication is practically complete and installation is beginning.

4) A ship propulsion reactor, basically a power reactor. This project is now in advanced stage of engineering design.

Specific reactor projects seem to have been adequately handled through research and design stages. The program might be said to be on a "construction plateau." The bets are made, and resources committed. Results will be known later.

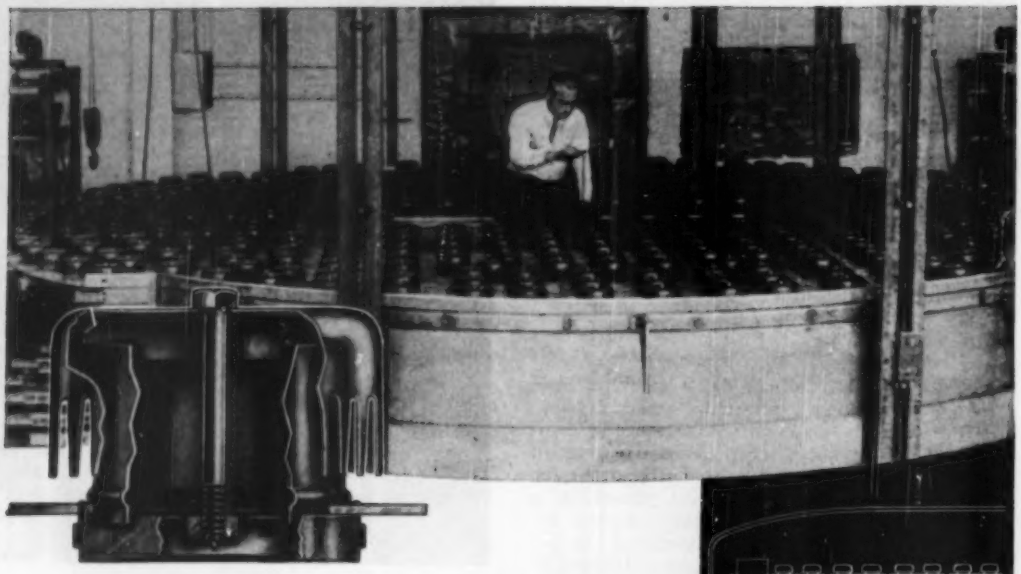
Reactors are expensive. Small one cost from $1 million to $5 million; full grown ones $25 million to $50 million. Reactor designs are numerous. The problem is to select one which will yield maximum returns. To justify building an expensive reactor we must have a demonstrable need. To assess the need we must know costs, but costs can only be determined by building reactors. To break out of this vicious circle, we have used the fact that the unknown economic factor is less compelling for military needs.

Critics of the American atomic energy program make the assumption that civilian atomic energy could be made generally and cheaply available if only those in authority had the will to do it. Another billion dollar crash program of the Manhattan Project type is visualized. Actually, there is little in common between the atom bomb problem and the civilian power program. The civilian power program is quite different. If correct bookkeeping procedures were followed, the high costs of such a crash development program would have to be charged to the power ultimately produced, thus raising rather than lowering its cost.

Figures in the literature on estimated costs for atomic energy vary by at least a factor of ten. The variables influencing these figures are complex. The ship propulsion reactor is our currently best available yardstick for nuclear power costs. A rough figure for this has been given as $1400 per kwh installed capacity for nuclear power, as against $133 for the corresponding equipment of a conventional power plant. Reduction in the costs for nuclear power will eventually be made along several routes. A factor of two or three may be picked up on the relatively fixed cost of power production by conventional means, and the gap between $1400 and $133 lessened appreciably.

Turning to the fuel cost problem, the item is not negligible. Taking from the open literature a

Top-of-page photo—View of Sunray Oil Corporation's Duncan, Okla., catalytic cracker which last month set a new record for continuous operation of a Fluid unit. See story, page 147.



proven improvements in bubble tray design—

One truss for every two trays . . . with every alternate tray level free of major supports — this is the new bridge-type truss design that makes Gilbarco Duo-Level bubble trays faster to install, far easier to clean, and more rigid with lighter weight.

New cap assemblies are designed for quick, easy removal by one man working from the top side. There are no flanges or projecting edges around holes to slow up cleaning operations.

A new clamp design with improved packing protection minimizes joint leakage without causing distortion of the trays under temperature changes.

Duo-Level bubble trays, fabricated of alloy metals, are adaptable to refinery requirements either as new equipment or replacements. Gilbarco's large staff of engineers is at your service to demonstrate how Gilbarco bubble trays can be fabricated to meet the requirements of your process design.

Gilbarco

GILBERT & BARKER MFG. CO.

West Springfield, Mass. Toronto, Canada

Established in 1865

figure of $20 per gram for nuclear fuel as a basis, we still get a fuel cost of one mill per kwh, as compared with 2 mills for chemical fuels. The $20 figure is almost certainly low and seems likely to increase as the supply of high grade uranium ore runs out. For single purpose civilian power-producing reactors burning U-235, the conclusion still is that for nuclear power the cost of fuel will be about the same as for conventional plants, while the cost of installation (and probably its operation) will be considerably higher.

"Summarizing then, and focussing our attention on trends, we note that discussion and interest has shifted from the question of whether reactor power reactors can be built, to which should be built and which will prove most economical. This represents real technical progress. Current efforts are proceeding on two fronts, a direct attack on those problems confronting reactors for which there is a present real demand, production and mobile reactors, and a parallel attack on the applied research front, looking toward proved technological advances which at some future date can be safely incorporated in the main line of large reactors. We note a trend toward complex multipurpose reactors with civilian power probably emerging first as a by-product from production reactors and perhaps ultimately in its own right. Finally, we note an increasing interest on the part of the Commission to consider proposals for industrial participation."

Giving Customer The Best Value

IF THE oil industry places too much dependence upon government specifications, both the consumer and the individual oil companies will suffer, a veteran oil man warned in a recent address to an American Chemical Society group in California.

While the petroleum industry has "immense capability for developing good products to meet consumer needs," it has fallen into the habit of using government specifications as standards for commercial product development, asserted A. Bruce Boehm, sales manager of the Enjay Company, Inc., New York. When this condition prevails and major emphasis is placed upon attaining a place on the government approved lists, the oil man is encouraged to make the cheapest oil that will pass government specifications rather than the oil that will best meet the consumer's needs.

The oil companies themselves will be hurt by this practice, Boehm stated, because the consumer will be led to view one approved oil as being little different from another, and will therefore buy from the published lists at the cheapest price. He also criticized engine builders who find the government specifications a suitably detailed definition of minimum quality for use in recommending oils to their customers. This reliance on the approved lists, he said, places upon the government the burden and responsibility for official approval or rejection of what the oil industry submits. Should an oil marketer choose to rely upon his research staff to design a product to meet the equipment needs, he may fail to obtain the engine builder's mark of approval merely because he has not obtained a place on the government's approval list, although the product may be perfectly satisfactory, it was pointed out.

Boehm expressed the hope and belief that oil men and engine builders can work out the problems so that research in both industries may yield the best value for the customer.

Adequacy of the Rubber Supply

THE rubber industry should be able to supply all military and essential civilian rubber product needs in the coming year without alarming shortages, according to John L. Collyer, president of The B. F. Goodrich Company, Akron, Ohio. His recent statement is on the basis of requirements outlined by the National Defense Program for 1951.

It is anticipated that the nation will be on a wartime, or a preparation-for-emergency basis for a long time. Collyer advocates a seven point program to attain rubber security as soon as possible for the United States, as follows:

1) Rapidly increasing the output of American rubbers from the current rate of 570,000 tons a year up to the authorized rate of 920,000 tons.

2) Increased usage of American rubbers as rapidly as they become available.

3) Addition of any excess production of American rubbers to the government's inventory, up to a reasonable limit, as a protection against damage or dislocation of rubber-producing facilities.

4) Government exchange with foreign countries of any remaining excess production of American made rubbers for crude rubber.

5) Government effort to prevent sales of crude rubber to Russia. The purpose of our present limitation program on the consumption of crude rubber in the United States is to make more crude rubber available for our own strategic stockpile.

6) Government accumulation of crude rubber in a strategic stockpile, to the extent justified by a careful study of our military and essential civilian requirements in an extended emergency. (A study should be made of the possible effect upon the economics of our own and other nations if we accelerate our stockpile purchases rapidly and then cut them off abruptly.)

7) A congressional study to be made promptly on the question of whether the continuance of the present government monopoly in general and specific purpose rubbers is in our long-range national security interests.

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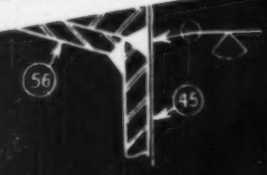

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DWIGHT F. BENTON

A REVOLUTIONIST SPEAKS—

Oil Industry Would Aid U. S. In Safeguarding Its Freedom

DWIGHT F. BENTON
Manager of Sales, Standard Oil Company (Indiana), Chicago

WE AMERICANS are facing strong challenges on two fronts. These challenges must be met or we will never again enjoy the kind of life we like. One of these challenges is from outside our country—communism.

Although communism profeses to be a new movement, it is the most reactionary in the world. It seeks to conquer the world by force. Is there anything new in that? It seeks to control the world with the power of one man or a handful of men whose decisions are final as to life or death, the way of family or church, what you do or what you get out of it. Is there anything new in that?

All anyone has to do is to take a glance through the recorded pages of history to see that rule by force has never produced prosperity for any long period—it has never produced peace for any long period—it has never produced happiness.

Speaking simply as one American I want to speak as a revolutionist. Against the reactionary forces of communism—or call it socialism or fascism or any other control by force—we can pit the strength of the only really revolutionary idea of government and life in the world.

That idea, brought forth in the birth of our nation, is as fresh and bright and inspirational today as it was only little more than a century and a half ago. It is the idea of freedom.

Events of recent months in world affairs have made some things pretty clear about what lies ahead for all of us. In Korea, in China, in Indo-China, and elsewhere the communists have prowed openly what—let's admit it—we know they have stood for for more than a third of a century, world domination for communism. They have now reached the stage of power where they can openly blast from without as well as bore from within.

As a result we as a people are embarking upon a very costly program of rearming ourselves against the possibility of further armed aggression.

The Korean war and our diplomatic troubles with Red China have shown that our problem is not Russia. It is communism. It is the world trend toward socialism. Now what is socialism? It boils down to a belief that a few men running a government can handle everything better for a nation than millions of free individuals can, as they cooperate with one another in their own free way, and as they compete with each other in their own free way for the rewards of effort.

We are winning the war in Korea. We are holding our own and perhaps even gaining somewhat in other parts of the world that are fogged in with the cold war. It remains to be seen whether we will dissipate our strength in a series of little hot wars or whether the world will shake in a titanic struggle by the two principals, Russia and the United States.

Regardless of these possibilities we can still lose the war against communism and against socialism without gunfire and without bloodshed—if our government goes on limiting freedom of the individual and of enterprise till the point is reached that everything about our lives is planned and directed for us from Washington.

This can happen a little at a time, until it is an accomplished fact. Although there is no such thing as absolute freedom for the individual, all of us in this country still have more freedom as individuals than the average individual has anywhere in the rest of the world.

So the batle ahead is of two kinds. It is a battle against the armed forces of communism all around the globe and it is a battle against the socializers in our own country. Some of us here may get into the clash between the armed forces of communism and those of freedom, but all of us can and should get into the battle here at home. It would be a foolish paradox to let freedom slip away from us here, the very freedom which our armed forces are prepared to sacrifice their lives to save elsewhere in the world.

We owe it to ourselves and to our children to fight everywhere for our revolutionary idea of freedom. Some of us may not know it but we have here in this country something approaching the dreams and the goals of the wise men through the ages. We can expand what we have to make it even better if we are willing to fight for it.

How can we understand the superiority of what we have? Well, whenever we try to compare socialism and free individualism we get mired in a lot of details. We find the differences can be really complicated and difficult to make generally understood.

But if we compare the records of the two ideologies we see the differences pretty clearly. Here in America we have freedom of opportunity, and that is a very restricted thing in most of the world. We have freedom of worship, something that is by no means permitted everywhere. We have freedom from police or state terrorism in sharp contrast to the blanket of fear that covers many people. We have freedom of travel. We could name a great many individual areas of freedom. Actually these are all one freedom—and I stress the idea again that this is the most revolutionary idea that the world has ever seen.

It is easy to point to the physical results of this freedom. We have only 7 percent of the world's population and only 7 percent of the land area. With this very small percentage of the world's people and living space we have a tremendously high percentage of the things that make it possible for us to produce more and to live better. We have more than half of the world's telephone, telegraph, and radio networks. We have more than a third of the railways, more than three-quarters of the world's automobiles. We consume more than half of the world's rubber, almost

half of the steel, a quarter of the coal, and nearly two-thirds of the crude oil.

There is no question about the superiority of our way of life. The only countries that approach us in living standards are those that approach us also in giving free reign to the individual, to capitalism, to competition and to the profit motive.

Here in America we find that the life of the ordinary man has changed more in the last 50 years than it did in all the 500,000 years of mankind's existence before that. When we seek the reason we find it was because never before had millions of individuals been so free to think things out for themselves, to invent things, to start businesses, to make their own decisions, to compete with each other, to enjoy the profits of competition and to invest these profits intelligently for more progress.

There is no better illustration of how the process has worked than as shown in the petroleum industry. Only half a century ago the ways of man were pretty much as they were in biblical times. For most people, housing and clothing and food were simple and rough. Few people traveled far beyond their own home county and most of them traveled at the speed of the horse —four to five miles an hour.

In 1850 the muscles of man and beast supplied 94 percent of all the energy in use. Today we are using nearly 23 times as much total work energy as we did in 1850, but only 6 percent is supplied by the muscles of man and beast. Today coal and petroleum and natural gas and a little water power supply the 94 percent. In our own generation the use of petroleum and natural gas has quintupled while the use of coal has practically stood still.

Oil and gas were unknown as a practical source of energy. But in 1859 something happened that did more to change our way of life than did any of dozens of more famous historical events. That was the birth of the oil industry. The first commercially successful well was drilled in Titusville, Pa. There was little excitement immediately but a world eager for better lighting, better fuels, better lubricants and many other things was not slow to learn that the secret of obtaining them was locked in petroleum.

About 500 barrels of petroleum were produced in 1860. In 1929 the figure reached a peak of a billion barrels. Two billion barrels were produced in 1948 and now even that record has been topped this year.

The petroleum industry has powered a revolution in production, in human transportation, and in living in general. At first an illuminant and a fuel for stoves, oil has become a vital source of energy for automotive transportation of all kinds including tractors, those invaluable movable power plants on the farm. It has become a most important source of fuels for both domestic and industrial heating. It has become almost the exclusive source of materials for lubricating the machinery of the machine age. It has become a main source of road surfacing and roofing materials. Today it is the source of many more chemicals than most of us realize.

The Miracle of Transportation

Only 52 years ago the first horseless carriage was sold. Today we have more than 41 million motor cars, trucks, and busses. With hundreds of thousands of miles of good roads stretching from our front doors, and abundant fuel and lubricants for our cars and trucks, all of us have a freedom of movement and of travel for both ourselves and our goods that was undreamed of even 50 years ago. Of the paved roads and streets in this country 85 percent are surfaced with petroleum products. Through the gasoline tax they have also been largely paid for out of the petroleum dollar.

Petroleum has given us ability to travel at almost incredible speeds as compared with the crawling of a half-century ago. In 1903 Wilbur Wright flew his plane 120 feet at 30 miles per hour. Recently the world was circled in a nonstop flight of 23,452 miles in 94 hours and one minute. We can cross the continent between lunch and linner.

Petroleum has revolutionized agriculture. Fifty years ago the typical farmer was still almost as closely rooted to the the soil as when America was first settled. By working from dawn to dusk he could raise enough to feed himself and four or five other persons. Town was still a long, jolting trip away. Shopping had to be done mostly at the crossreads general store. Petroleum has lifted the farmer from a serfdom of toil and given him that same unlimited freedom to circulate that we all enjoy. Gasoline does most of his hard work on the mechanized farm. Other oil products fertilize his land and kill weeds and insect pests. As a result the farmer today can, with less physical effort, raise enough food for himself and fourteen other people.

There are now 10 million fewer horses on farms than there were in 1928. With the farm production it once took to feed those horses we can feed 40 million people.

On the average the farmer can buy 50 percent more gasoline with a bushel of corn than he could even in 1940. On the average the industrial worker can buy 50 percent more with an hour's labor. Although gasoline is worth on a performance basis 50 percent more than it was in 1925, it is selling on the average at a lower price. The price of gasoline has not increased nearly so much as the prices of food, clothing, home furnishings, and many other products.

Only 32 years ago the first oil burners were installed in homes. Now almost four million homes have central heating systems fired with oil, and another 5½ million using kerosine in space heaters. Thanks to oil and gas, automatic heating of homes has ceased to be a luxury and has become commonplace.

Oil is a major source of raw materials for synthetic rubber, fertilizers, alcohols, commercial solvents, plastic materials, synthetic textile fibers, disinfectants, and many other commodities. It provided almost all the toluene to make the TNT our bombers used to blast the enemy in World War II. It provided most of the materials that went into so-called 100-octane gasoline, without which the record of our airmen could not have been as brilliant as it was. Even nylon, originally made from coal and air and water, is now largely made from oil and air and water.

Things like those the petroleum industry has accomplished for the good of mankind show the superiority of free individualism over any form of social planning imposed from the top of the political structure.

Few, if any, Americans really want communism. The principles of communism are foreign and repulsive to people who have earned and enjoy the benefits of freedom. However, the subtler approach of socialism can open a chink in our armor that could prove fatal to our beliefs. Socialism is the Trojan Horse of communism.

For this reason we have a great task at home as important as our rearmament and mobilization against military aggression. There are three elements to this task:

First, to make people realize there is a peril. I have great confidence that Americans everywhere believe in freedom and want to keep it but they must see the danger to freedom if they are to fight it.

Second, to fight for the principles of freedom here at home. A people on guard will permit no chink in their armor.

Finally, to work for the extension of the benefits of freedom to the peoples of other lands. It is in our interest as well as theirs that they learn the superiority of the revolutionary idea of freedom over the reactionary dogma of communism. It is our only road to lasting peace.

In the war of ideologists there is work for everybody who wants to keep America the land of the free. Oil com-

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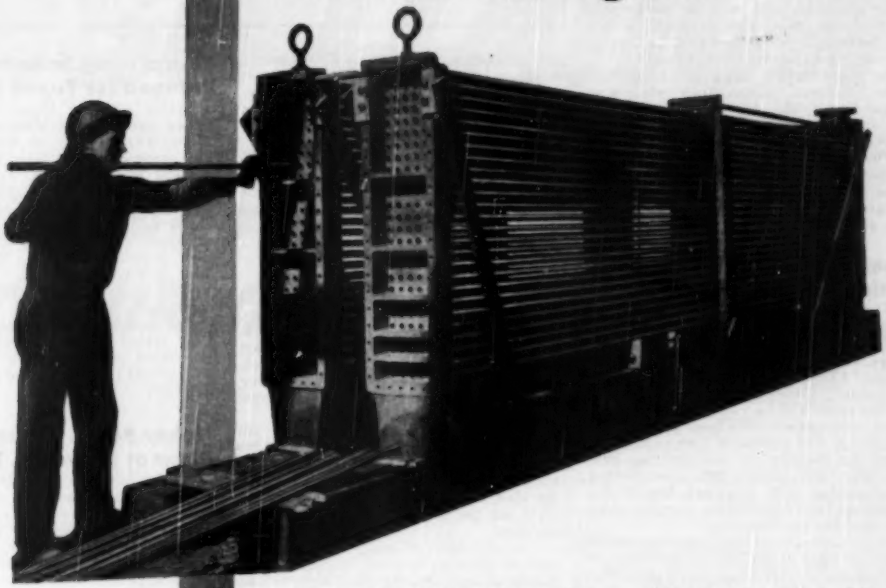

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panies recognize that fact. They are dedicating a lot of effort among some two million employes to do their share of the task. The oil industry people want their friends and neighbors everywhere to know the blessings our industry enjoys and the blessings the American people enjoy as the result of the work of free oil companies; privately owned and competing with each other.

We hope to convince people that American business, like our American political system, must remain free from the encroachments of socialism if all of us are to remain free individuals. If we believe that, we must do something about it.

Notes on Refinery and Other Plant Construction

Petroleum Refiner's Next "Box Score" Tabulation Will Appear in the January Issue

Indiana Standard to Expand Neodesha Refining Capacity

Engineering work on expansion of refining capacity at the Neodesha, Kan., refinery of Standard Oil Company (Indiana) has been started, and actual construction will begin early in 1951. The crude running capacity will be upped by 9300 barrels per day—an increase which will almost double the present 10,400-barrel capacity.

Existing crude oil distillation, coking and rerunning units will be revamped. In addition, new tankage and utilities will be installed together with new units for improvement of product quality.

Surplus cracking stock will be moved from Neodesha to Standard's refinery at Sugar Creek, Mo., for processing on the cat cracking unit completed there in 1948.

The first phase of the Neodesha expansion program is expected to be completed early in 1952. Later, cracking capacity will be expanded, probably by the addition of a cat cracker.

Shell to Add Platforming Units at Two Refineries

Plans to construct two new refining units, largest of their kind ever to be built, were announced by Shell Oil Company. One unit will be at Shell's Wood River, Ill., refinery, and the other at Houston.

The units will be Platforming installations, and orders have been placed with Universal Oil Products Company, Chicago, for engineering and designs. Procon, Inc., will perform field construction. Platforming will convert low-quality naphthas into high-octane number components for gasoline.

Each unit will process naphthas at the rate of 630,000 gallons daily. The installations are expected to go on stream by October, 1951.

Derby Oil Awards Contracts For Refinery Expansion Plan

Contracts have been awarded by The Derby Oil Company for construction of a new Socony Thermofor catalytic cracking unit, a Universal Oil Products catalytic polymerization unit, and a gas concentration plant at its Wichita, Kan., refinery.

The new equipment is of designed capacity for increasing future crude runs of the refinery up to 15,000 barrels per day. The Thermofor catalytic cracking unit is designed to process 7500 barrels of virgin gas-oil per day. The polymerization unit and the gas plant are also sized for increased crude capacity. The Fluor Corporation, Ltd., will handle engineering and construction.

The total expansion program will run in excess of $2 million, and units are scheduled to be in operation in 11 months.

Badger Receives Contract For Continental Equipment

Continental Oil Company has awarded a contract to E. B. Badger and Sons, Boston, for the design and construction of processing equipment which is part of the $10 million construction program that will double the crude oil charging capacity of Continental's Lake Charles, La., refinery.

The expansion program, which will increase the refinery crude capacity to 25,000 barrels daily, will include the installation of a Thermofor catalytic cracking unit and additional auxiliary equipment for the production of high octane gasoline.

The enlarged refinery will manufacture, in addition to a full line of domestic gasolines and heating oils, high octane aviation gasoline.

The construction program, to be directed by Harold G. Osborn, Continental vice president in charge of manufacturing, is scheduled for completion in the early part of 1952.

Builds Lake Charles Plant

The newly formed Continental Oil Black Company, owned by Continental Oil Company and Continental Carbon Company, is constructing a $1.5 million high abrasive carbon-black plant at Lake Charles, La. Raw materials will be obtained from the nearby Continental Oil Company refinery.

Shell Finishes Canada Unit

Construction of a vacuum flashing unit at the Montreal East, Quebec, Canada, refinery of Shell Oil Company of Canada, Ltd., has been completed. A fluid catalytic cracker and other additional units are scheduled to go into operation in December, bringing the daily capacity of the refinery to 35,000 barrels. Contractors for the improvements are The Fluor Corporation, Ltd., and Arthur G. McKee Company.

More Construction Notes, Page 152

Platforming Installation Planned for Texas Plant

Taylor Refining Company, Taylor, Texas, and Mayfair Minerals, Inc., McAllen, Texas, plan to install a UOP Platforming unit in their jointly owned refinery at Port Isabel, Texas.

Construction of the 4000-barrel-per-day unit, designed and engineered by Universal Oil Products Company, Chicago, will get under way as soon as possible, according to G. L. Rowsey, president of Taylor Refining Company, and V. E. Cook, president of Mayfair Minerals, Inc.

The addition of the Platformer to the Port Isabel refinery is part of a modernization and expansion program and will permit the production of high-octane gasoline.

Huber Builds Carbon Black Plant at Baytown, Texas

A $1.5 million carbon-black manufacturing plant eight miles north of Baytown, Texas, being constructed by J. M. Huber Corporation, is scheduled for completion by March 1, 1951. It will have a capacity of 30 million pounds of HAF type carbon black.

The site, which includes 300 acres, is on the flank of Barber's Hill field in Chambers County and a few miles from Esperson Dome field of Harris and Liberty counties. Raw material for the operation will come from nearby refineries.

McBride Constructs Unit

McBride Refining Company, Inc., has completed construction of a Perco cycloversion unit at its LaBlanca, Texas, refinery. The unit was engineered by Grebe & Doremus Process Company, Houston.

The new processing section has a design capacity of 1000 barrels per stream day to reform straight-run gasoline and full range field distillate.

England Plant Contracted

Head Wrightson Processes, Ltd., London, has been awarded a contract by Vacuum Oil Company, Ltd., to construct a grease plant in Birkenhead, England. The plant, which is estimated to cost $1 million, is scheduled for completion by early 1952. Wrightson Processes is also engineer for the project.

Build Japanese Refineries

Lubricating oil refining plants near Tokyo, Japan, are under construction by Toa Nenryo Kogyo KK and Mitsubishi Oil Coy., Ltd. Both plants are being engineered by Separator-Nobel.

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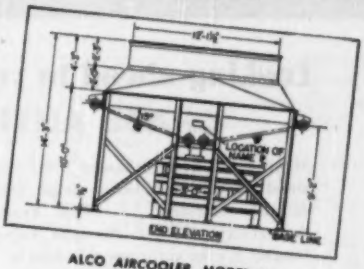

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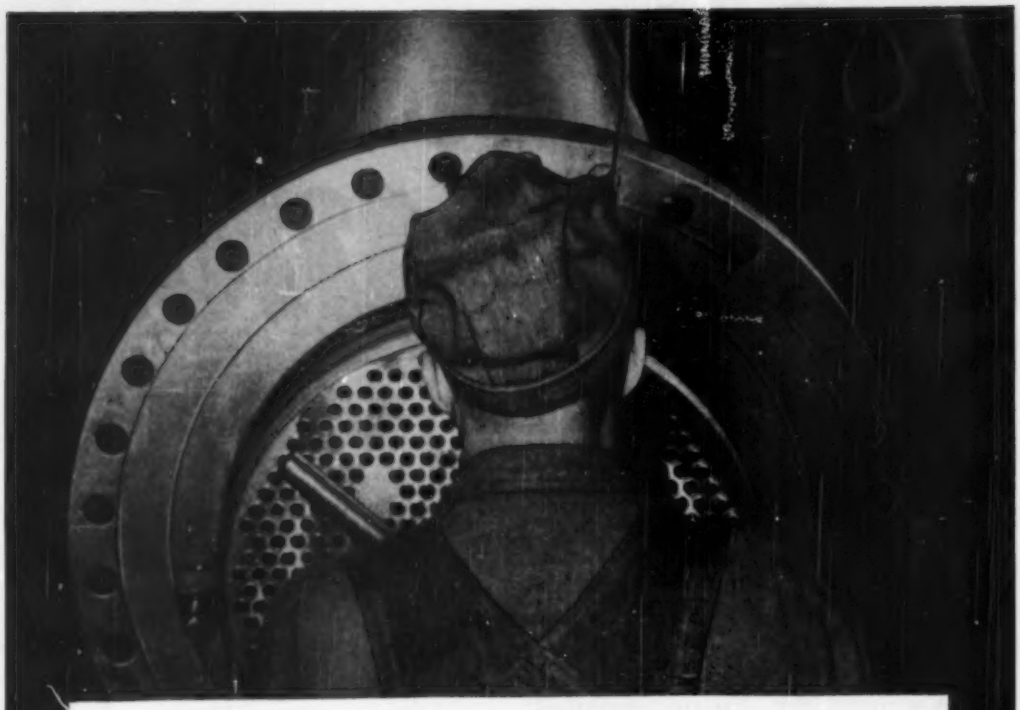

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PETROLEUM
REFINER
DECEMBER, 1950

Figure 1. A stream of burning gas emerging from a bore hole at the underground coal-gasification project at Gorgas, Ala., creates a pyrotechnic display reminiscent of an oversize Roman candle.

Petroleum Industry Has Definite Role in Synthetics Development

JAMES BOYD

Director, U. S. Bureau of Mines, Washington, D. C.

DURING World War II concern over supplies of domestic petroleum prompted Congress to see what could be done toward supplementing liquid petroleum products with those derived from other sources, such as oil shale and coal, both of which are abundant in the United States. Following congressional hearings, the synthetic liquid-fuels act was approved on April 5, 1944, authorizing an intensive research program on the production of liquid fuels from oil shale, coal, and other substances. It directed the Bureau of Mines to obtain, in cooperation with private enterprise, the necessary scientific, engineering, and economic data for the development of a synthetic liquid-fuels industry.

THE STRENGTH of our economy in war and its continued progress in peace both depend fundamentally on the availability in the future, as in the past, of adequate supplies of low cost energy to power our vast industrial machine. Increasing demand for liquid fuels during the last two decades has led to research and development, by both industry and government, on processes for the manufacture of synthetic fuels. Many authorities believe that a new industry based on the conversion of coal and oil shale to gasoline and other liquid fuels must be started soon. In addition to providing a dependable source of gasoline, diesel fuel, and other products for centuries, a synthetic fuel industry would create a new and steady market for coal. The petroleum industry, because of its long experience in refining and marketing, would play a major role in the construction and operation of this new industry. Original presentation was before a Divisions of Refining and Marketing session, API meeting, Los Angeles, November, 1950.

Conditions have changed since passage of the synthetic liquid-fuels act, but many parallels could be cited on both our international and fuel problems. That measure was enacted during World War II, when our troops were fighting in the European theatre. Today we are still in the midst of world crisis.

Demand for oil once more is increasing far more rapidly than some anticipated. With the armed forces marshaling their strength and with civilian requirements continuing to advance, refining and transportation already are feeling the pinch, and crude supplies are tightening. Competition for steel has again developed. A cold winter in the populous East would add new urgency to these familiar echoes of the last war.

Should World War III come, civilian rationing of gasoline and fuel oil might be much more stringent than in past wars. Further, it again would be necessary to disregard the maximum rate of efficient recovery in drawing on our petroleum reserves.

Water transportation of oil doubtless would be as great and perhaps a greater problem than during the early stages of World War II. With much of the naval shipbuilding activities of various nations reported to be directed toward modernized submarines, it becomes obvious that overseas tanker lines from the Near East and South America would be difficult to maintain.

Our future, internationally, remains inscrutable; but one thing is certain—our dependence upon oil has increased and greatly.

Total demand for oil and oil products is expected by the Bureau of Mines to reach 2432 million barrels in 1950—a gain over 1949 of about 9 percent. Domestic demand is estimated at 2330 million barrels, an increase of more than 10 percent. The trend is even more apparent when we consider the per-capita demands of the past 30 years—4.3 barrels in 1920, 7.6 barrels in 1930, 10.1 barrels in 1940, and an estimated 15.5 barrels in 1950.

More than half of all the fuel energy used in the United States now is provided by oil and natural gas. Even without war, basic economic factors indicate a continuing growth of demand in years to come. Higher wages and living standards, together with an increasing population, have created a mass market for the more convenient liquid and gaseous fuels. Transportation is almost wholly dependent upon oil. Industry and agriculture, confronted with costs for labor which are relatively higher than

those for new equipment, have turned to labor-saving machinery which also requires oil and gas.

If we had unlimited supplies of all fuels, these facts would be of no concern. Our reserves of petroleum are relatively limited. In recent years we have found some comfort in the volume of annual additions to proved reserves. A record exploratory effort has since 1946 improved the reserve position with relation to rates of production, but one cannot assume a continuation of recent experience for an extended period of years. Moreover, costs have risen sharply, for more and deeper wells now must be drilled to find oil. The American petroleum industry currently is spending almost $200 million a month for exploration, development, plant modernization, and expansion.

For some years new oil fields discovered in the U. S. have been decreasing in size and importance. The opposite is true of discoveries made abroad. Whereas the average new field found in this country rarely exceeds 2 million barrels of recoverable oil, the 300 fields discovered abroad during the 2 decades prior to 1943 have an estimated ultimate yield averaging about 100 million barrels each. Our potential oil land, of course, has been far more intensively explored. We have drilled one wildcat well for every 12 square miles of average land area here, in contrast to one drilled for every 480 square miles abroad. We now have less than one-third of the proved oil reserves of the world, and the land area of Russia alone may be a greater potential source of new oil than continental United States.

It is conceivable, of course, that unexpected discoveries of very large new pools may occur in this country. The widely heralded Scurry County, Texas, reef development is a timely example. Estimates have been made that this field's reserves may total well over a billion barrels. It must be remembered, however, that even this amount is less than a six-month supply at the current rate of consumption. Satisfying this nation's present oil thirst for a full year would require almost the equivalent of the entire production to date of the largest field ever found in this country—East Texas—which has produced a cumulative total of 2.6 billion barrels during its 19 years of life.

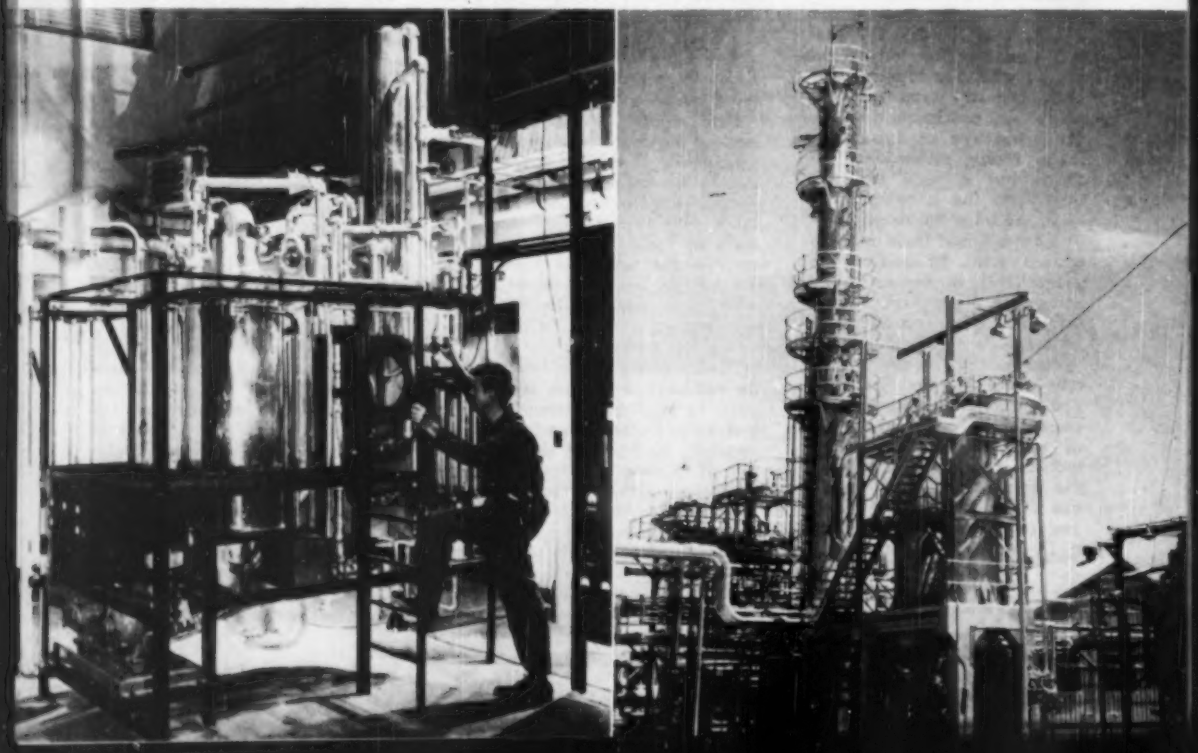
As the midway point of the 20th century, this year marks the beginning of a significant decade—a decade in which eminent authorities in both the petroleum industry and government have indicated that domestic petroleum production probably will pass its peak, and may begin a long gradual decline.[1, 2, 3, 4, 5] Moreover, they anticipate that this decade will witness the birth and initial development of a new basic industry engaged in producing synthetic liquid fuels initially from natural gas; then oil shale, and coal.

Barring unexpected developments in atomic or solar energy, the anticipated widening gulf between domestic demand and supply ultimately will have to be met by synthetic liquid fuels and imports. Of the two, only synthetics can offer an assured supply from known resources within our own borders—a supply which is not subject to vulnerable sea lanes, foreign expropriation, or exhorbitant taxes and concession fees.

This country's first commercial synthetic fuels plant, built at Brownsville, Texas, by Carthage-Hydrocol, Inc., is scheduled to begin producing gasoline and other liquid fuels from natural gas soon. Other plants, using as raw materials oil shale and coal as well as natural gas, almost certainly will be in production before the decade

Figure 2. Experimental Adiabatic Retort at the Bureau of Mines Petroleum and Oil-Shale Experiment Station at Laramie, Wyo. This unit is used to determine the amount of heat required to retort oil shale under various conditions. It is designed to hold 50 pounds of shale, and can operate at temperatures between 600 and 1150° F.

Figure 3. Experimental Refinery at the Oil-Shale Demonstration Plant at the Bureau of Mines Near Rifle, Colo. This highly flexible unit can apply to shale oil many refinery techniques. Equipment (from right to left): heater (partly obscured), reaction chamber, coke chamber, flash-fractionator tower, sidecut stripper, stabilizer, and rerun column.



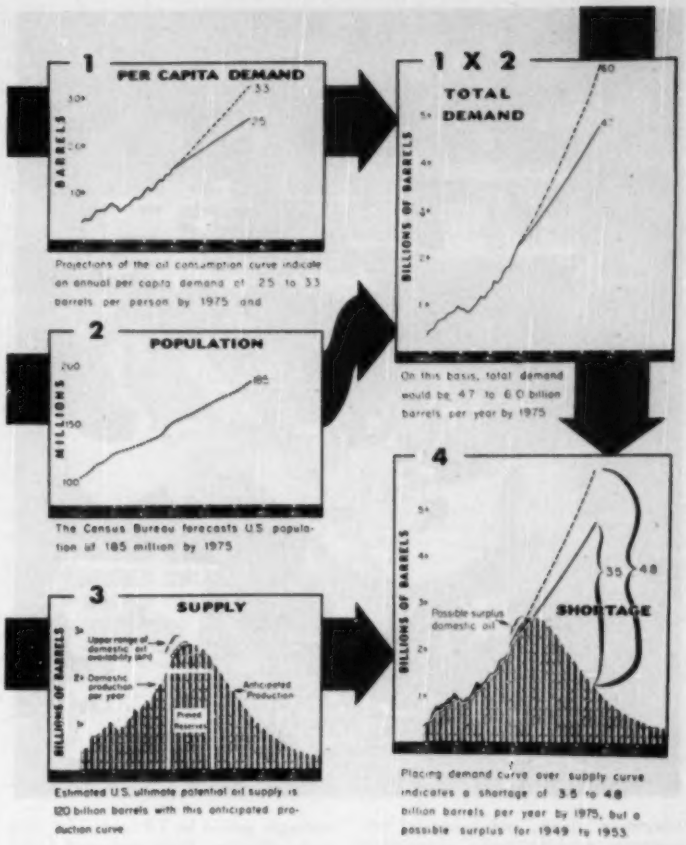

1
PER CAPITA DEMAND
BARRELS
Projections of the oil consumption curve indicate an annual per capita demand of 25 to 33 barrels per person by 1975 and
2
POPULATION
MILLIONS
The Census Bureau forecasts U.S. population of 185 million by 1975
3
SUPPLY
BILLIONS OF BARRELS
Upper range of domestic oil availability (est.)
Domestic production per year
Proved Reserves
Anticipated Production
Estimated U.S. ultimate potential oil supply is 120 billion barrels with this anticipated production curve
1 X 2
TOTAL DEMAND
BILLIONS OF BARRELS
On this basis, total demand would be 4.7 to 6.0 billion barrels per year by 1975
4
BILLIONS OF BARRELS
Possible surplus domestic oil
SHORTAGE
35
48
Placing demand curve over supply curve indicates a shortage of 35 to 48 billion barrels per year by 1975, but a possible surplus for 1949 to 1953

Figure 4. U. S. Oil Problem. Solution to Future Shortage Synthetic liquid fuels + greater imports + secondary recovery + oil from submerged lands.

ends — if research and development progress maintains its current pace.

It is obvious that the security of our liquid-fuels position will be greatly enhanced when the supply is based in part on solid fuels, such as coal and oil shale, which make up more than 95 percent of our overall fuel reserves.

The primary concern of the government is that the current pressing demand for petroleum may lead to a serious inadequacy of domestic reserves before alternative sources of essential fuels and lubricants have been secured. The essentiality of oil to both our economic and military security points to the need for rapid development of synthetic liquid-fuel processes during this period of seemingly abundant petroleum—an "abundance" which might prove deceptive and illusory in the light of emergency needs.

The Present Program

To date the research and development program originated by the synthetic liquid-fuels act has demonstrated that high-quality liquid fuels can be produced from coal and oil shale, both of which are available in vast quantities within this nation's borders. However, many difficult technical problems remain to be solved, and I do not wish to minimize them. Legislation has been passed by the Congress to extend for an additional three years the research work necessary to tackle these problems.

A substantial part of the time and money expended thus far has of necessity been required for the construction of the necessary laboratories and demonstration plants. All now are completed and in operation with the exception of a gas-synthesis demonstration plant at Louisiana, Mo., which will convert coal to oil by a modified Fischer-Tropsch process. Major construction work on this plant was completed in July, and integrated operation is scheduled for early next year.

At Louisiana, Mo., too, a coal-hydrogenation demonstration plant has made a successful vapor-phase and five liquid-phase runs. This plant converts coal to oil by an improved Bergius-I. G. Farben, process. Both demonstration plants use facilities of the Missouri Ordnance Works, a wartime synthetic ammonia plant.

At Bruceton, Pa., near Pittsburgh, laboratories and pilot-plant units are developing, testing, and improving these processes for converting coal to oil. They were completed early in 1948.

At Morgantown, W. Va., on the campus of the University of West Virginia, a small laboratory and several pilot plants have been established to investigate and develop methods for producing low-cost synthesis gas from coal. Gasification of coal is not only the first step in both basic processes for producing synthetic liquid fuels from coal, but the ranking problem now requiring solution. The synthetic-fuels extension act contains a provision for expanding the facilities at Morgantown for this important work. Members of this station's staff, in cooperation with the Alabama Power Company, are conducting a field project in underground gasification of coal at Gorgas, Ala.

At Rifle, Colo., on the U. S. Naval Oil-Shale Reserve, an oil-shale demonstration plant and experimental mine have been functioning for three years. There, new methods are applied for mining and retorting oil shale and for refining shale oil.

At Laramie, on the campus of the University of Wyoming, a building for the petroleum and oil-shale experiment station was completed in May, 1946. Fundamental research is in progress on the chemistry of oil shale and shale oil, and on the development of more efficient retorting and refining processes.

The Bureau of Mines demonstration plants have four primary objectives: 1) to provide industry with essential engineering and cost data for commercial-scale plants—data which cannot be obtained from laboratory or pilot-scale units; 2) to test various American coals and shales to determine their practical yields and solve any problems associated with their utilization; 3) to provide quantities of finished products for large-scale testing by the armed forces and others in motor vehicles, airplanes, and ships; and, 4) to ascertain the feasibility of laboratory process improvements in larger equipment. The Department of Defense is now testing, in military equipment, the oil products obtained from coal and oil shale in these dem-

Figure 5. A Three-Yard Electric Shovel Loads 15-Ton Diesel Trucks on the Bench Level of the Experimental Oil-Shale Mine Near Rifle, Colo. A portable utility station (upper left) supplies air to the benching jumbo (upper right) for drilling blast holes into the floor of the top level.

onstration plants, and industrial laboratories working under cooperative agreements with the Bureau of Mines also have obtained samples for research and test purposes.

This country has the best equipped and staffed facilities in the synthetic fuels research field. With major emphasis now centered on operation rather than on design and construction, the government's synthetic fuels program has entered its most valuable period, and is making rapid strides. Full operation of these facilities, with any necessary modifications to incorporate process improvements, unquestionably will solve many of the problems now prevalent.

Past Accomplishments

Significant progress already has been made, both by industry and government. In terms of product cost, as estimated by the bureau's engineers, recent research and development achievements mean that refined products now could be produced from oil shale and coal at estimated actual costs averaging 7.3 cents and 10.3 cents a gallon, respectively, with credit for chemicals and other byproducts. Without credit for chemicals, the cost averages would be 7.9 cents and 14.8 cents a gallon. These estimated costs, of course, do not include return on investment. However, they are approaching the competitive range. Further reductions are certain as technical knowledge is advanced, permitting additional process improvements.

At the request of the Secretary of the Interior, a committee of the National Petroleum Council is now reviewing the bureau's estimates of synthetic fuel-production costs to determine what improvements can be made. Production costs are of paramount importance in orienting a program as extensive and complex as the bureau's synthetic fuels' work, and interest in the estimate has been widespread. There is, of course, no better yardstick than cost of production for determining the relative merits of the numerous existing processes for making synthetic fuels, as well as the many improvements under development.

The bureau's established objective has been to obtain accurate, acceptable data, and to publish them in as much detail as practical, so that anyone can use the information to the fullest extent by substituting his own values if the factors used do not apply to his operation or geographic area.[6] Before publication, all estimates are reviewed by one or more reliable industrial

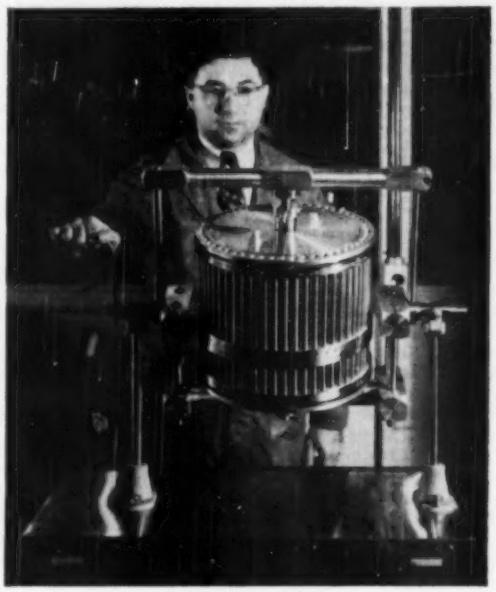


Figure 6. Countercurrent Distribution Apparatus. This apparatus was developed for the separation and analysis of very small quantities of closely related compounds, such as anti-malarial drugs and penicillin preparations. At Bruceton, Pa., it is used to determine the composition of complex tar-acid mixtures found in a product from hydrogenation of coal.

firms familiar with the processes involved. Criticisms received have been informative and helpful, if not necessarily consistent between reviewers.

In any normal economy, production costs for synthetic liquid fuels would determine in large measure when commercial plants were built. As mentioned earlier, one such plant using natural gas as its raw material is scheduled for completion this year. Its capacity reportedly will exceed 7000 barrels of liquid products daily.

Reporting on the long-term availability of petroleum, the subcommittee of the API's National Oil Policy Committee has estimated that synthetic production from natural gas will increase to approximately 30,000 barrels per day by the end of 1953.[7] Basing its forecasts upon the plans of industry and the economic conditions prevailing during the first half of 1949, this committee, headed by L. F. McCollum, predicted that production of synthetics from natural gas would increase at an accelerated pace as needed during the subsequent five years, 1954 through 1958, and would be supplemented by a relatively small output from plants converting both oil shale and coal to oil.

"In considering the outlook for synthetics," the committee reported, "there is obviously a wide latitude for judgment because of the many conditions that might arise to change the conclusions significantly." Since that report was issued, our military forces have been expanded somewhat, and hostilities have occurred in South Korea. The Korean hostilities have added only about 2 percent to domestic requirements for petroleum products, but the threat of a greater conflict is always present. As twice demonstrated in the present century, a nation to remain a major power must have liquid fuel resources immediately and continuously available in virtually unlimited volume. Oil is the *sine qua non* of military victory, whether it is obtained from petroleum, coal, oil shale, or all three.

Another pertinent factor which conceivably might speed up the schedule of synthetic fuel plant construction is the current shortage of benzene and phenol. Increasing requirements have induced the Bureau of Mines to undertake an investigation of these and other chemicals available in large quantities as byproducts of synthetic fuel production from coal and oil shale. Potential benefits of this study of processes, yields, and markets include: 1) a new source of those chemicals either now in short supply or expected to be in times of emergency; 2) a supplementary source of aromatics or other special fuel components required by the armed forces; and 3) reduction of the cost of synthetic fuels by the co-production and sale of chemicals. Constantly becoming more important as a basic raw material, benzene is required in making synthetic rubber, plastics, nylon, and detergents and, during the past war, was used to make cumene for aviation gasoline.

The Senate Report

After an extensive investigation of petroleum resources in relation to the national welfare, a special Senate committee investigating petroleum, under the chairmanship of Senator Joseph C. O'Mahoney of Wyoming, stated, in its final report[6] issued early in 1947, that:

"Until such time as synthetic production costs are not in excess of those of production from crude oil, there will be a natural temptation in peacetime to meet domestic deficiencies with imported petroleum. But to the extent that the volume of imports is permitted to grow during such period, the nationwide industrial plant necessary for synthetic production will fail to emerge through private investment. This is not to say that the manufacture of synthetic fuel should be fostered by a governmental policy designed to force prices up, thereby rendering such manufacture commercially profitable, but rather that the Bureau of Mines should continue to build and operate demonstration plants, and to conduct research . . . to the end that the transition may be made promptly at the appropriate time."

In view of our immense reserves of

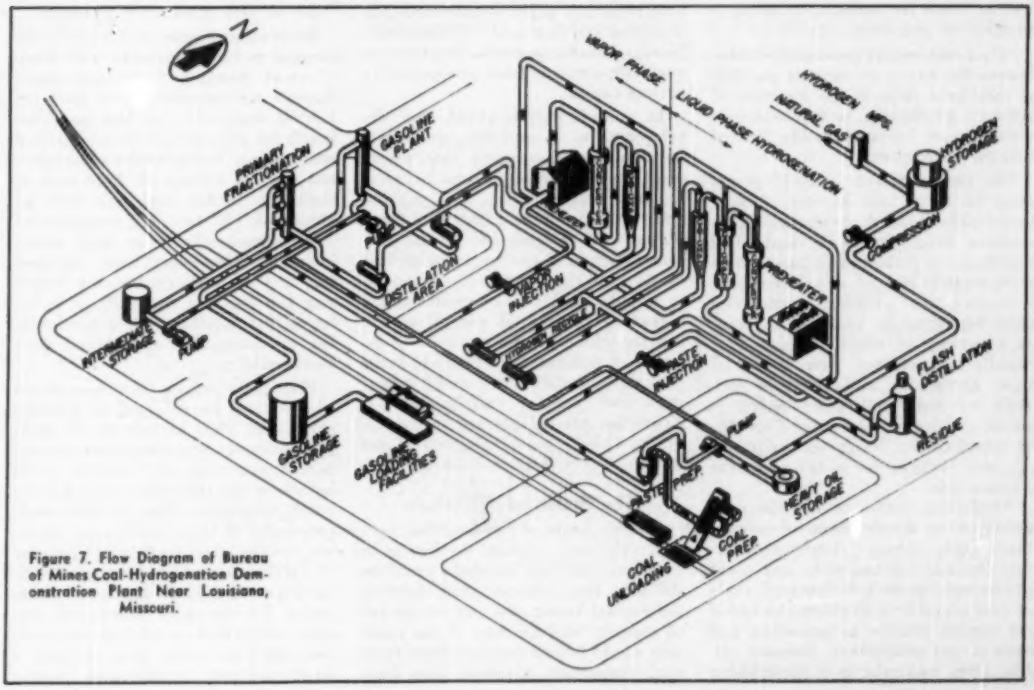


Figure 7. Flow Diagram of Bureau of Mines Coal-Hydrogenation Demonstration Plant Near Louisiana, Missouri.

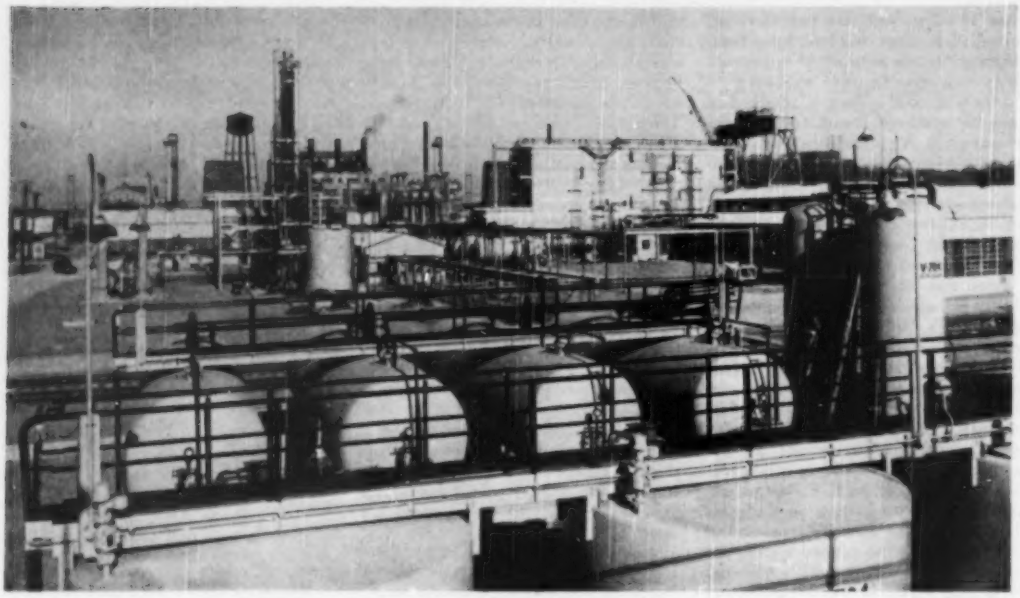


Figure 8. Coal-Hydrogenation Demonstration Plant of the Bureau of Mines at Louisiana, Mo. In this plant a pattern of "know how" is being cut for a new American industry based on the conversion of coal to oil. Beyond the product-storage tanks in the foreground are the distillation facilities (at left) and the converter stalls (at right).

coal and oil shale, which are estimated to be capable of meeting all domestic liquid-fuel requirements for many years, the committee held that there was no cause for concern regarding a shortage of petroleum.

"But," the report concluded, "it behooves the nation as soon as possible to take bold steps in the direction of synthetic production, so that such production can become readily geared into the oil economy."

The time required to build plants must be taken into account. A synthetic fuels industry of significant proportions hardly could be established during a war if the nation had to start from scratch. Instead, as in other basic industries, the pioneer commercial units first must be available to serve as a pattern on which to expand as rapidly as necessary. Even if one of your companies authorized an oil-shale or coal-to-oil plant today, it would require at least several months to complete the design and engineering, and perhaps one to two years for construction.

Production costs are not the only deterrent to development of a synthetic fuels industry. Under the current internal revenue code, any plant producing liquid fuels from oil shale or coal would have to assume an added tax burden relative to petroleum and natural gas production. Because oil, like other minerals, is a diminishing resource, and because investments incident to exploration involve unique risks with danger of large financial loss, the Congress through income-tax provisions has allowed deductions for depletion and intangible drilling costs. Similar benefits might be necessary to stimulate synthetic fuels production by private capital.

In considering the birth and development of a synthetic liquid-fuels industry, we have noted that plants using natural gas as the raw material will rise first. However, it is improbable that any large number of such plants will be built for several reasons: 1) Natural gas is a valuable fuel in its own right, without conversion to liquids. 2) A rising demand and a spreading network of pipe lines are rapidly taking off the market idle reserves of natural gas which are large enough to justify the capital investment for synthetic fuel plants. 3) Prices for natural gas are on the upgrade. 4) Like petroleum, natural gas is a relatively limited resource.

The Status of Oil Shale

On the basis of information now available, it is probable that in a peacetime economy oil shale would be the next raw material used, because the capital investment per barrel-day of capacity and the cost of the products would be less than for those from coal. Important advances have been made recently in each major phase of the oil-shale research program: 1) in mining raw shale; 2) in retorting shale for recovery of oil; and, 3) in refining shale oil into marketable products.

Shale-mining costs, which once were thought to be comparable with those of coal mining, have been pared through mechanization to a level below 60 cents a ton, or less than one-fourth the average cost of underground coal mining. In the bureau's last mine-test run, an average of 1628 tons of shale was broken each day, with an output of 148 tons per man-shift of underground labor. For total labor, including direct supervision, engineering, and all maintenance, the output was 116 tons per man-shift. It is believed that no other underground mining operation ever approached these averages.

Pilot-plant retorts have been tested which could be enlarged to produce more than 1000 barrels of oil daily by continuous processes, as contrasted with a maximum of 5 barrels to 50 barrels a day formerly available by batch processes. One of the more promising of these continuous retorts was developed by Union Oil Company of California, and has been tested with shale provided by the Bureau of Mines under a cooperative agreement. Another which looks good is the bureau's own gas-flow retort. Both employ a high-capacity continuous process

which, in a commercial operation, would require no additional fuel other than the byproduct gas and residual carbon on the spent shale.

Crude shale oil now can be refined readily to useful products, for its sulfur and nitrogen content is no longer a major problem. A mild hydrogenation of the crude oil will yield jet fuel, diesel fuel, and fuel oil meeting military specifications. A supplemental thermal or catalytic cracking step is necessary to make motor gasoline. Solvent-extraction methods also are under intensive study, and appear promising on both operational and economic grounds. Performance tests with shale-oil products have proved quite satisfactory.

The capital investment now required for a plant producing 8340 barrels daily of refined products from oil shale is estimated at $41,381,000, including facilities for mining, retorting, and refining. This is an average of $4681 per daily barrel of finished product. From a defense standpoint, it is significant that steel requirements for shale-oil plants are relatively modest in comparison with those of either coal-to-oil plants or new petroleum facilities plus exploration and development. Then, too, once the initial commercial shale-oil unit was established, plant capacity might be expanded rapidly; for the location of the reserves is known, and little or no exploration in its usual sense would be necessary.

A market for the products must be considered, for the oil-shale area of western Colorado is sparsely populated and might not absorb the entire output of a 10,000-barrel-a-day plant. Only rail transportation is now immediately available. Construction of a 50,000-barrel-a-day pipe line could provide transportation to large consuming centers at a total cost of less than 1 cent a gallon, but would require the output of five 10,000-barral-a-day plants for capacity operation.

Chemicals from Coal

Concern over current shortages and increasing requirements for chemicals has increased interest in the coal-hydrogenation process. Benzene and aromatic hydrocarbons generally, together with phenol and other commercial tar acids, can be produced in substantial amounts by the direct hydrogenation of coal.

A single 30,000-barrel-a-day coal-hydrogenation plant, producing principally gasoline and liquefied petroleum gases, could make a major contribution in alleviating shortages of such chemicals. For example, the estimated annual yield of a plant of this size would include 34 million gallons of benzene, 49.5 million gallons of toluene, 50.3 million gallons of xylenes, 34.5 million pounds of phenol, 57 million pounds of cresol, and 75 million pounds of xylenols. This is equivalent to almost 20 percent of the nation's 1948 production of benzene and 11 percent of the phenol output reported in that year (1949 was not representative because coal strikes curtailed production of these chemicals in coke plants). In addition, this plant would produce as major products 3.5 million barrels of motor gasoline, and 3.25 million barrels of liquefied petroleum gases. Yields of benzene, toluene, and xylenes available from such a plant could be increased 25 percent by recycling the higher-boiling fractions. This, of course, would reduce proportionately the yield of gasoline.

Shale oil likewise contains significant amounts of aromatic chemicals now in short supply. These include tar acids—phenol, cresols, and xylenols—together with tar bases, present as homologues of pyridine and quinoline. In a laboratory unit, the bureau has demonstrated that a highly aromatic stock can be produced by retorting pulverized oil shale with radiant heat, a process which is completed in a fraction of a second. The product, a gasoline-boiling-range material with an octane number near 100, may also be used as a source of aromatics. If radiant retorting can be proved commercially feasible in large-scale equipment, the yields of benzene and toluene available from oil shale by this process will be very impressive.

At times the synthetic liquid-fuels processes have been questioned from the standpoint of their efficiency, measured in terms of heat units entering a plant against those recovered in

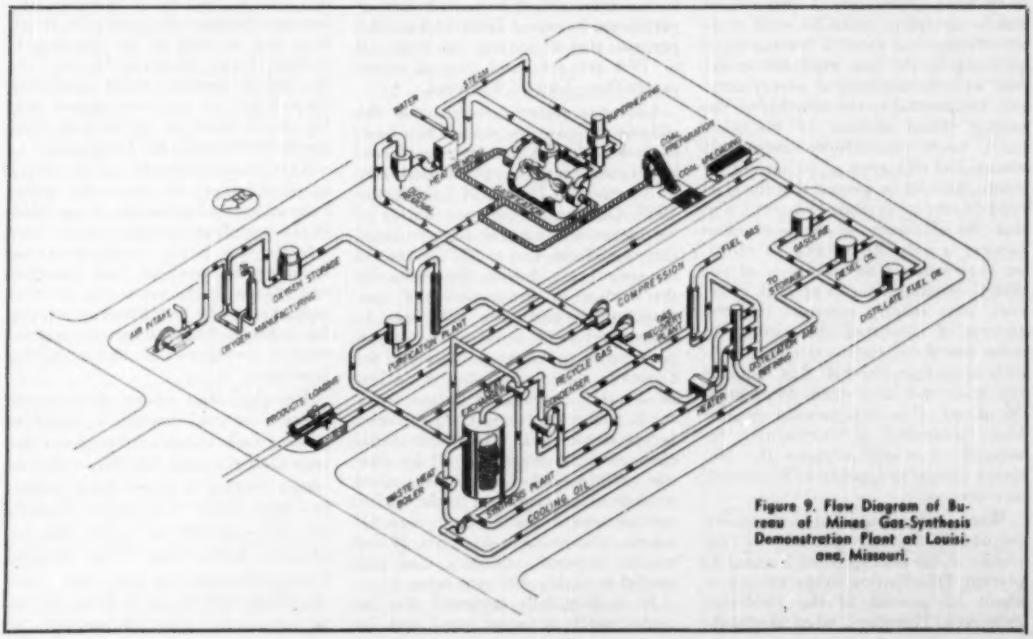


Figure 9. Flow Diagram of Bureau of Mines Gas-Synthesis Demonstration Plant at Louisiana, Missouri.

the form of liquid fuels. This is a complex question which cannot be answered either in brief or general terms.

However, as it pertains to oil shale, the pertinent point is that our shale is a vast but idle resource—one which we are not now using in any way. Oil shale becomes a net addition to this country's overall energy reserves with the development of low-cost processes by which it can be converted to useful liquid-fuel products. Therefore, any question of the quantity of heat put into a plant in the form of raw shale as opposed to the heat energy obtained in terms of liquid fuel is of little moment. Processes used in producing shale oil should be as efficient as possible, of course; but, so long as good recoveries of useful oil products are obtained, the significant fact is that we have dedicated to the continuing growth and prosperity of our nation a new and valuable reserve of heat energy.

Liquid-fuel processes dependent on coal, of course, will use a solid fuel or raw material which enters many markets. The loss of heat incident to the conversion of coal to liquid fuel at first might seem to be a direct reduction in the quantity of energy available to us, or the antithesis of true conservation. This is not entirely true, however.

To illustrate this point, let us examine briefly the energy factor prevailing in the increasing use of diesel engines on railroads, a transition now in its most active state. A steam locomotive operating on coal has an overall efficiency of about 8 percent when we compare the heat available in the coal with the mechanical energy actually transmitted to the drawbar of the engine. Diesel engines, on the other hand, easily can achieve an overall mechanical efficiency of 30 percent, or better. Now let us assume that the railroad diesel fuel is made from coal, and that the efficiency of the conversion process is only 50 percent. In effect, we have reduced the efficiency of our diesel locomtoive to 15 percent. However, it is readily apparent that the amount of converted coal needed to drive our diesel engine is still only a little more than one-half that required for direct use in a steam locomotive. Of course, if a coal-burning gas-turbine locomotive is successfully developed, it would improve the efficiency of coal utilization to 20 percent, or more.

When coal is converted to electricity, the overall thermal efficiency of conversion of the average plant is about 23 percent. Distribution losses amount to about 12 percent of the electricity generated. Therefore, when electricity is used for space heating, water heating, and the like, the over-all efficiency is about 20 percent. On the other hand, synthetic fuel processes will convert coal to liquid fuel suitable for these purposes with a conversion efficiency of at least 50 percent; with a combustion efficiency of 60 percent, the overall efficiency would be 30 percent—which is 1½ times as great as the 20-percent figure for the electrical method.

Gasoline, of course, is the fuel needed in huge quantities to power our modern automotive and aeronautical transportation. Obviously, an energy loss is inevitable in converting coal to a high-quality liquid fuel such as gasoline. However, it is noteworthy that, if desired, the product of a coal-hydrogenation plant can be 95 percent gasoline and liquefied petroleum gases, with essentially none of the heavier heating oils.

Energy Requirements

To review the general fuel picture, the pattern of energy consumption in the U. S. has changed drastically during the first half of the 20th century. Coal provided by far the greatest portion of our total energy supply in 1920; but petroleum, natural gas, and water power have absorbed almost the entire increase in our total requirements since then.[9] On the basis of percentage contribution to the total energy supply, coal declined from 78.2 percent in 1920 to 39.3 percent in 1949. In the same period the contribution of petroleum increased from 14.5 to 30.4 percent; that of natural gas from 3.9 to 19.4 percent; and that of water power from 3.4 to 4.9 percent.

Coal has suffered its sharpest decline in the past two years. On a heat-content basis, the contribution of coal to our total energy supply dipped from 50.4 percent in 1947 to 39.3 percent in 1949. Conversely, the contribution of petroleum and natural gas combined increased from 45.6 to 55.8 percent in the same years. Among the causes for the decline in production and consumption of coal since 1947 are: 1) sharp decline in bituminous coal exports owing to the rehabilitation of the European mining industry; 2) a loss of similar magnitude because railroads converted from steam to diesel locomotives; and, 3) a substantial changeover from coal to oil by electric utilities. Losses in these three markets alone amounted to almost 100 million tons in the 2-year period. Of course, the relative depletion of our several mineral resources has proceeded at highly different rates.

It is frequently assumed that we could readily reconvert our homes, industries, and transportation to coal, should shortage of oil products drive prices to high levels. Unquestionably there is a wide range of uses in which primary energy sources can be substituted, one for the other. In a practical sense, however, any wide reconversion from liquid to solid fuels is quite unlikely. There is no feasible substitute for gasoline, and we shall make it from coal and oil shale when this becomes necessary. As pointed out, the railroads could reduce their fuel requirements by making oil from coal and using this oil in diesel engines rather than using coal directly in steam locomotives. Householders and small industrial users already have strongly indicated their preference for liquid and gaseous fuels, and it is doubtful that many can be persuaded to return to solid fuels. Likewise the partiality for diesel oil and heavy fuel oil in ships' bunkers is firmly entrenched. In many instances even the utilities operating on oil will not voluntarily reconvert to coal, particularly in the Southwest, and in California where coal is not readily available at low prices.

Looking Forward in Liquid Fuels

The Bureau of Mines believes that it may be desirable to approach the fuel problem with another viewpoint. Perhaps we should assume that the synthetic fuel processes have established a price ceiling which petroleum products cannot readily exceed. If petroleum products break through this ceiling, conversion processes will become economically profitable. It follows that, so long as the consumer is willing to pay the price, he can have the fuel he prefers. At the same time these levels do not now appear very far above those at which petroleum products currently are being sold.

This prospect should not be viewed as discouraging to either the petroleum or the coal industries. Undoubtedly the petroleum industry would have a major role in the development and operation of synthetic fuel processes and plants. At the same time the coal industry would be offered a solution for some of its most serious postwar mining, transportation, and marketing problems.

Processes now under development convert the coal entirely to liquid or gaseous fuels suitable for pipe-line distribution. No solid residue is left to crowd further a diminishing market for solid fuels. The liquid products are the equivant of, or in some instances better than, those obtained from petroleum. As they come from the plants, they would be ready for use in present-day airplane engines, jet

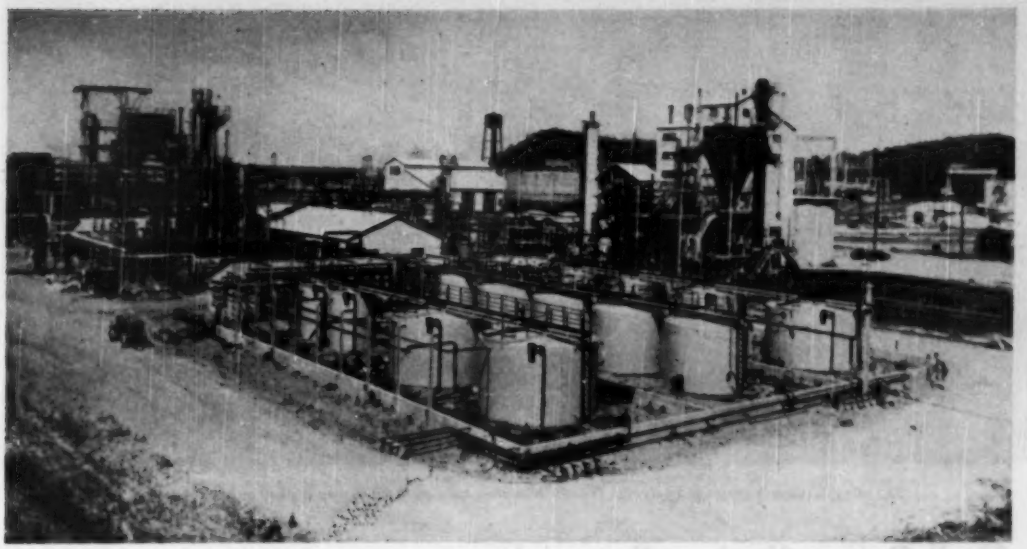


Figure 10. Gas-Synthesis Demonstration Plant of the Bureau of Mines at Louisiana, Mo. Employing a modified Fischer-Tropsch process, this plant will convert coal to oil. Left to right: the synthesis unit, the product-storage area (foreground), the oxygen unit (building in front of water standpipe), the coal-gasification unit (tall structure at right), and the coal-storage area.

engines, automobiles, diesel engines, and domestic and industrial oil burners. In short, the processes are developed far enough to make coal a suitable raw material for any liquid fuel requirement.

All ranks of coal may be used in such plants—anthracite, bituminous, subbituminous, and lignite—which will allow all the coal-producing states to participate in the development of a new industry based on these processes. The mines would not need to produce graded sizes of coal, ranging from lump for domestic use to small sizes for industrial consumers. Synthetic fuel processes can use run-of-mine coal, or even fines. This means that the mines can be developed for high output of a single product with the use of the new continuous mining machines. In some mines output per man-day with these new machines brings the cost of mining coal underground near a competitive position with strip-mining operations.

Coal would move directly from the mines to the synthetic fuel plants. Mine and plant operations would have to be integrated, and the mines would be in production not two or three days a week, but on full schedule the year round. This should contribute materially to stabilizing employment in the industry, as well as to achieving lower costs.

Products from the plants would be all liquid or pipeline gas. The only solid material would be ash from the coal. Products can flow to the consuming centers by low-cost pipe-line transportation—eliminating, in a major degree, the burden of high costs under which the coal industry now must labor in taking a solid product to market.

And finally and most important of all, the product, when it reaches the consumer, will be in the form which the majority seems to prefer—either as oil or gas.

The strength of our economy in war and its continued progress in peace both depend fundamentally upon the future availability of adequate supplies of low-cost energy to power our vast industrial machine.

International events of recent months have demonstrated once again that the United States should be substantially self-sufficient in its mineral fuels. There is much to be done toward furthering the develpoment of synthetic liquid fuels from coal and oil shales, but it cannot be done overnight—we have no time to lose.

No one is better aware of these needs than the petroleum industry itself. In all the work on synthetic liquid fuels, the Bureau of Mines has enjoyed the co-operation of the various oil companies, as well as other industrial research organizations. Almost 40 cooperative agreements have been entered into by the bureau. Among these —just to mention a few—are Gulf Research and Development, Hydrocarbon Research, Koppers, Phillips Petroleum, Shell Development, Sinclair Refining, Socony-Vacuum, Standard Oil Development, Standard Oil of California, Universal Oil Products, and Union Oil of California. The Bureau of Mines is deeply appreciative of the interest shown by oil companies, and of the splendid active cooperation it is receiving not only from those with which it has written agreements, but also from all progressive members and associates of the petroleum industry. With such cooperation, I am confident that we can successfully accomplish the task of assuring the nation of an adequate supply of essential liquid fuels.

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Shell's research center at Emeryville. The new laboratory building is the U-shaped structure in the center.

Shell Opens Modern Research Building at Emeryville, Calif.

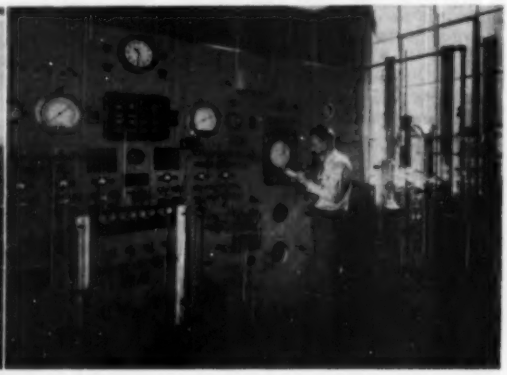
SHELL Development Company on November 21 officially opened a new four-story building, together with other important additions and extensions, at its extensive Emeryville, Calif., research center. More than 5000 people, including scientific writers and press representatives from all parts of the country, were taken through the facilities to witness many research projects now under way. Considered the largest petroleum research center in the West, the unit claims as some of its important achievements the development of butadiene for synthetic rubber, toluene for TNT and 100 octane and super aviation gasolines. Some of the unusual peacetime products developed include synthetic alcohol and glycerine, Epon and diallyl phthalate resins and plastics, new additives for motor oils and vapor phase corrosion inhibitors to prevent rusting. The new additions to the plant provide additional space for more diversified activities at the Emeryville laboratories and permit the consolidation of all activities in one location for integrated and efficient operation.

Most important function of Shell Development Company, the research and development affiliate of the Shell companies in North America, is to find ways of making new products from petroleum and to devise improvements in known products and processes by which they are made.

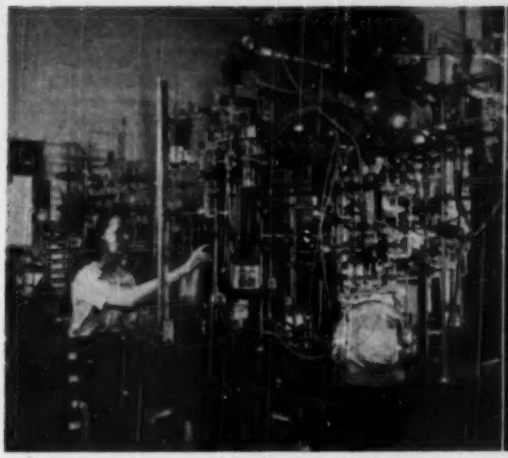
Since it was established in 1928, the company has grown from a staff of 35 chemists and assistants to the present total of 1100 employes having more than 100 different scientific and technical skills. About 435 hold college degrees, with 120 of these at the doctorate level.

The company is organized into two major divisions: (1) Research division and (2) Development division. The Research division does fundamental research on long term projects and applied research toward new products and processes. The Development division advances new projects through process development and pilot plants to full

This test panel in the instrumentation laboratory provides accurately controlled pressures, flow rates, and electrical equivalents for testing and evaluating refinery control devices.



In Shell's hydrogenation laboratory, the behavior of refinery stocks at high pressures is studied, in order to help refineries to obtain the maximum amount of gasoline from each barrel of crude.



This apparatus is used in making fundamental studies of metal film catalysts, to determine the relation in size between the surface structure of a metal and the molecules which combine or break up readily at that surface.

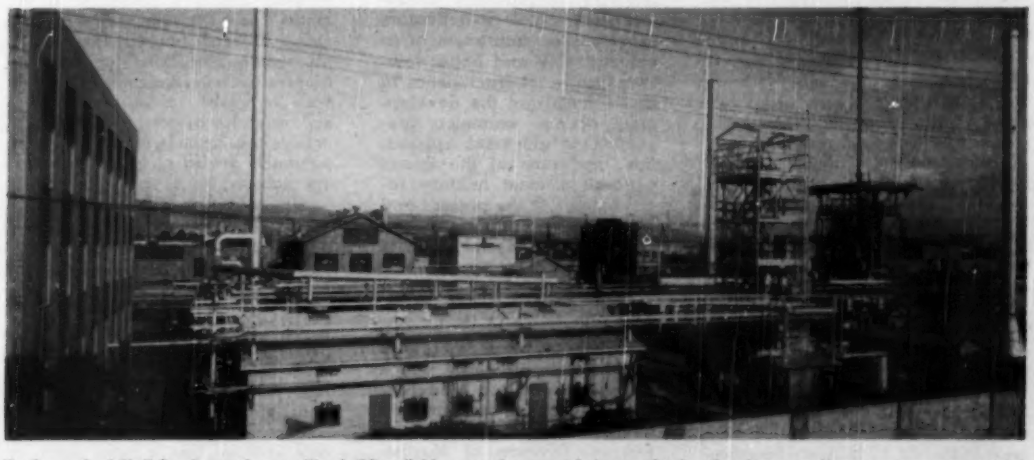
A multiple four-ball machine in Shell Development's Lube Oil Group. The effectiveness of lubricating oils is tested by measuring the wear on ball bearings running under heavy pressure while immersed in oil sample.

scale production. Research is of several types. Fundamental studies of catalytic cracking and motor laboratory studies of the mechanism of lubrication are continuing long-range projects. Currently, work is being done on improved utilization of residual oils, which today are of considerable potential economic value. Past projects now firmly established on a commercial basis are production of iso-octane, toluene, and lubricating oil additives. Processes developed and licensed to other companies for use on a royalty basis include the solutizer process for removing sulfur compounds from gasoline and the phosphate treater process for removing hydrogen sulfide from gases. Other licensed processes deal with alkylation, isomerization, microspheroidal cracking catalyst, oil base drilling muds, butadiene production, penicillin recovery, toluene recovery, direct applications of ammonia fertilizer to irrigation water and soil, pipe line corrosion inhibition, etc.

The laboratories, views of which are shown, are on a seven-acre site. The three principal buildings, totaling 127,000 square feet of floor space, contain most of the research laboratories, offices of the Development division and Patent department, and the administrative and general offices. Another major unit, the service building, is located at the south end of the area and includes the motor laboratory, shops and stores. Included among the numerous departments are some employing atomic energy, the electron microscope and elaborate testing devices, all being used to further the numerous research projects, some of them of classified nature whose details cannot be divulged, now under way at the laboratory.

Dr. M. E. Spaght, president of Shell Development, officiated at the opening ceremonies. Opening of the new laboratory coincided with the regular meeting of the board of directors of Shell Oil Company held in San Francisco. H. S. M. Burns, president of Shell Oil Company, and a number of the company's directors attended the formal opening of the new facilities.

The photographs show details of the new laboratory and specific examples of work conducted there.



To the south of Shell Development's new office building (left), a complex array of pipes marks the pilot plant area. Here, new processes are tried out on a small scale in order to study costs and iron out operating difficulties before a full-size commercial plant is built. The tall frame structure in the right foreground is used for experimental studies of oil refining processes; the structure just to its right, with the tall, thin, flat-topped stack, is used for production of acrolein.

Fuels and Lubricants Needs Listed by Army

BENJAMIN S. MESICK
Washington, D. C.

SIMPLIFIED supply and wide range of usability have long been the objectives of the fuels and lubricants program of the army. The present situation in Korea has served to emphasize the need for meeting those objectives, and as soon as possible. We are operating at the end of a 7000-mile supply line to a combat zone approximately 400 miles long, where the temperature ranges from sub-tropical in the summer in one section to arctic in the winter in another section of the peninsula. From the standpoint of logistics, the number of different types of materials to be supplied to such a combat area must be kept to an absolute minimum. A few classes of materials, suitable for use in many applications over a wide temperature range, simplify supply and decrease the possibility of using the wrong material as might be the case if a wide variety of materials was available for different purposes.

Inasmuch as a considerable interest has been shown in possible changes in specifications for fuels and lubricants resulting from the development of new equipment and from new tactical requirements, it is felt that, in discussing trends in technical requirements of fuels and lubricants for the army, this information should be presented in turn for each class of petroleum products.

Fuels

As in World War II, it is basic that only one class of gasoline will be furnished to combat theatres. This gasoline is currently described in Military Specification MIL-G-3056, dated September 30, 1949, which is actually the same as the old U. S. Army Specification 2-103C. With the trend toward higher compression-ratio truck engines now being procured by the military, and with the development of the air-cooled tank engine, it has been necessary to consider improvement in this Specification MIL-G-3056. The following changes are being made in the specification: the addition of a minimum research octane requirement of 86; a change in the 50-percent point to 239° F. maximum; and a change in the 90-percent point to 356° F. maximum, in the type "A" gasolines. In addition, it is now mandatory to use a minimum of 1 pound per 1000 barrels of an approved metal deactivator in both type "A" and arctic grades of gasolines. These changes will eliminate the low-sensitivity 80-octane motor-method gasoline procured since the end of World War II in large quantities under the current specification; and the change in volatility brings type "A" military gasoline more closely in line with current commercial grades of premium gasoline.

IMPROVED oxidation inhibitors and metal de-activators in gasolines, improvement in compatibility and better low-temperature characteristics in diesel fuels and the development of one corrosion preventive of universal application are some of the things needed to meet military requirements at the present and as anticipated in the near future. Colonel Mesick, who is chief of the Research and Materials Branch of the Research and Development Division, Office of Chief of Ordnance, also discusses equipment and logistics requirements which influence fuels and lubricants trends. Original presentation was before a lubrication group session, Division of Marketing, at the annual API meeting, Los Angeles, November, 1950.

With the gradual change in the composition of civilian motor gasolines over the past few years, there has been an increased tendency to lower oxidation stability and, in some cases, metal sensitivity. All previous data on the use of oxidation inhibitors and metal deactivators were based on the predominantly straight-run gasolines such as were used in World War II. It will be necessary to re-evaluate these characteristics in terms of the expected composition of newer fuels because some of the results may not be valid when applied to fuels which contain large percentages of thermally and catalytically cracked components. This problem has been presented to the Motor Fuels Division of the Coordinating Research Council, Inc.; and a program is now being prepared for cooperative tests designed to provide both improved oxidation inhibitors and metal deactivators, as well as laboratory test methods, which will more accurately predict such factors as storage stability.

Although the percentage of diesel engines used in the various types of army equipment is rather small compared to gasoline engines, there are certain applications, such as construction equipment, which will continue to be diesel-powered. A great need is apparent at the present time for diesel fuels which have better low-temperature viscosity characteristics, lower pour points, and improved starting characteristics. Our investigations to date indicate that a pour point of —65° F, maximum; a viscosity of 1000 centistokes, maximum at —65° F.—starting at —20° F. without auxil-

iary starting aids—are proper goals to achieve in the near future.

The need for improvement in oxidation stability and of compatibility of diesel fuels, which is recognized as a commercial problem, will be a "must" for military operations.

At the present time it is not contemplated that there will be an increase in ignition-quality requirements above the present specification. We feel that the logical solution to our arctic problem may be found in fuels which fall within the range of jet fuels meeting the requirements of specification AN-F-58a.

Engine Oil

The extreme conditions of operation which may be encountered by the army have necessitated the development of an engine oil to meet these more severe requirements. Satisfactory operation must be achieved at ambient temperatures from —65 to +125° F., under conditions of very high load. These conditions necessitate the development of oils which have unusual viscosity characteristics, high resistance to oxidation, high detergency, and freedom from formation of objectionable deposits. The general trend toward fuels of higher sulfur content and increased amounts of cracked components has led to increased engine wear and corrosion, and to the formation of excessive varnish and sludge.

For many years heavy-duty engine oils which met the requirements of U. S. Army Specification 2-104B gave satisfactory service with the types of fuels then being used. However, it was recognized that there was a need for decreasing the wide spread in quality levels between the best and the poorest oils which met that specification. For this reason a new specification, MIL-0-2104, was issued August 4, 1950, with the intent of setting the level of quality approximately at that of the top-level 2-104B oils. That this has been successful is evident from the fact that most of the former top-quality 2-104B oils have recently been qualified under the new specification. It is felt that oils which meet the requirements of MIL-0-2104 are a definite improvement over the old 2-104B oils, and that this improvement has been obtained without materially sacrificing availability.

One change in Specification MIL-0-2104, which will be made in the very near future, is intended to bring the viscosity requirements of the specification in line with the new proposed SAE standard. Other than this, no immediate changes in the specification are contemplated. After more experience has been obtained, other changes may be indicated.

Problems being encountered in new tank-engine designs indicate the possible need for control of the amount of metal ash formed on combustion of these oils. Oils with sulfated residues as high as 2.0 percent and as low as 0.24 percent are now qualified as MIL-0-2104 oils. In some cases deposits have contributed to preignition in tank engines which are already operating at critical temperatures.

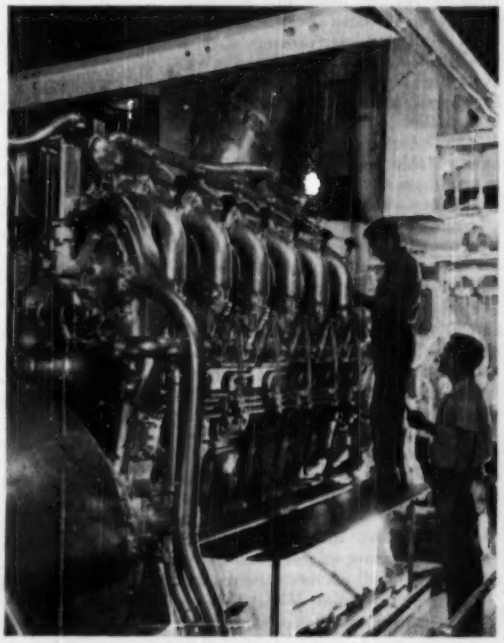
Although the army is cognizant of the possibility of silver-bearing corrosion with engine oils of this type, where sulfur content and activity are not controlled, our experience to date with army engines which contain silver bearings indicates that, where lubrication is not otherwise critical, no silver-bearing corrosion is being encountered. In the absence of any confirmed need at this time, a silver-bearing corrosion test is not being considered in the future requirements of MIL-0-2104 engine oils.

The use of MIL-0-2104 oils in transmissions will also be under very careful surveillance. Oils which contain very active sulfur caused failures in certain tank transmissions during the last war. We must be alert to this possibility again and, if necessary, place some control over sulfur content and activity in MIL-0-2104 oils.

The next item for which there is a continuing need for improvement is in sub-zero engine oil. During the winter of 1946-47, during maneuvers in Alaska, considerable difficulty was experienced in starting and operating military equipment at the extremely low temperatures encountered. Engine oil was one of the factors which contributed to this unsatisfactory performance, for at that time the SAE 10 grade of U. S. Army Specification 2-104B type oil was the standard material for arctic use. Instructions prescribed dilution in the crankcase with 20 percent of the gasoline at temperatures below —20° F. However, at temperatures of —30° F. and below, it was impossible to pour the oil from drums without heating the container and, in general, crankcase dilution was not properly applied in the field.

Early in 1947 the Coordinating Research Council, Inc., was requested to assist in this problem. Based on previous experience, it was decided that the development was necessary of a sub-zero engine oil which could be poured from a drum at —65° F., and which would permit adequate cranking speeds at that temperature.

To expedite this development, it was decided to predilute the base oil at the refinery—using a volatile solvent. With the proper selection of base stocks and 10 percent of volatile dilution, it was possible to formulate an oil with a pour point below —65° F. and a viscosity of 10,000 ssu (Saybolt Universal) at —65° F. This oil, known as REO-15-47, was tested at Aberdeen



Diesel engines like the one shown here furnish the power to drive tugs and other land and water transport. Each calls for fuel and this, too, is a concern of the military.

Proving Ground and in the climatic hangar at Eglin Field, Florida; it was field-tested in the Alaskan theatre and in a convoy operation from Fairbanks, Alaska, to Detroit, Mich., during the winter of 1947-48.

High Consumption

This oil lubricated satisfactorily most transport equipment, but oil consumption was high, and some engines were damaged considerably because the crankcase-oil level was not checked frequently enough.

Following these field tests a new oil, known as REO-28-48, was formulated with a viscosity of 10,000 ssu at —40° F., a pour point below —65° F., and which contained 5 to 8 percent diluent. Extensive operation data and experience were obtained on this oil during the winter of 1948-49, and these helped to determine the characteristics of the present sub-zero engine oil. As a result of this service information, two oils were formulated and subjected to limited service tests. One oil was a blend of a synthetic oil and a petroleum oil, and the other was a straight petroleum oil. Both oils were used without dilution, and preliminary data at low temperatures showed satisfactory lubricating properties and about the same oil consumption as a standard SAE 10 grade oil.

On the basis of this experience, it was decided to use the straight petroleum oil, designated REO-72-49, for field testing during the winter of 1949-50. Results using this lubricant were generally satisfactory and, on the basis of the field-performance data, it was felt that sufficient information was available to write a specification for a sub-zero engine oil. Such a specification, MIL-0-10295, was issued May 5, 1950. The characteristics of this oil are: a stable pour point of —65° F.; a maximum viscosity of 8,500 centistokes at —40° F., and a minimum viscosity of 5.75 centistokes at 210° F. Other requirements include the ability the pass satisfactorily the AXS-1551 and the AXS-1554 engine tests.

To the present time, it has been difficult to produce an oil with the viscosity characteristics listed hereinbefore and at the same time to assure freedom from scratching, scuffing, and high wear rates in the engine. However, the ultimate goal in a sub-zero engine oil is to provide an oil which will allow cranking down to —65° F., which can be readily poured from the drums at —65° F., and which will provide engine operation with essentially the same performance as an SAE 10 grade heavy-duty oil which meets the requirements of Specification MIL-0-2104.

In view of these difficulties, it is felt that more effort needs to be expended on the development of additives which will satisfactorily prevent ring sticking, scuffing, and high rates of liner wear.

With the use of hypoid gears in military vehicles has come a requirement for extreme-pressure gear oils. Inasmuch as it is not feasible to supply a number of such materials, it has been necessary to develop performance and compatibility requirements which enable the procurement of materials which are satisfactory in all types of equipment. It is also essential that gear oils be developed to meet special operational requirements, such as those encountered in arctic operations.

At the beginning of World War II the only specification for gear oils used in army equipment was based on chemical composition. This was unduly restrictive from a procurement standpoint, and service performance was difficult to evaluate on such a basis.

In order to prepare a specification based primarily on performance requirements, an extensive program of laboratory testing and actual field-service tests was carried out with the assistance of the Coordinating Research Council, Inc. This program required almost three years to complete, and included more than 1,000,000 miles of road testing and about 5000 separate laboratory tests to determine such factors as stability, foaming, corrosion, effect of high temperatures, and the effects of high speed, high torque, and shock load.

As a result of this extensive program, U. S. Army Specification 2-105B was issued in March, 1946, and recently became Military Specification MIL-L-2105. This specification covers three grades of gear lubricant suitable for use over the temperature range of —40° to +125° F.

Since the issuance of the specification a number of deficiencies have been shown, and there is an apparent need for improvement of qualification-test methods.

Continuing Program

Current efforts to correlate the laboratory high-speed and high-torque tests with actual field performance have shown very erratic results. The corrosion tests used in qualification also have been demonstrated to have very poor reproducibility. A continuing program is being carried out in an effort to provide more satisfactory test methods which are capable of more accurate prediction of actual field performance under various conditions of loading.

The largest single improvement needed in gear oils at the present time is better corrosion resistance and the ability to prevent corrosion in the presence of small amounts of moisture. The work being done in cooperation with the Coordinating Research Council, Inc., on a new moisture corrosion test should point the way to the development of better materials.

Lowering the operating temperature requirement from —40° to —65° F. made it necessary to develop a sub-zero gear oil with essentially all the required characteristics of a normal extreme-pressure gear oil, but with much lower viscosity.

Field experience during the winter of 1946-47 revealed the 75 grade gear oils to be unsatisfactory for use in temperatures below —40° F. Gear-shifting effort became excessive when the viscosity of the gear oil exceeded approximately 130,000 ssu. It became apparent that an arctic or sub-zero gear oil of considerably lower viscosity and pour point was needed. With the assistance of the Coordinating Research Council, Inc., a gear oil was formulated with the following characteristics: pour point, —65° F.; channel point, —65° F.; viscosity of 36 ssu at 210° F., and 95,000 ssu at —65° F. This oil, known as RGO-28-47, was compounded with approved 2-105B additives and a viscosity-index improver. Considerable actual service experience had been obtained with this gear oil in temperatures ranging from those encountered during the Alaskan winter to normal ambient temperatures encountered in southern California; and to date operation has been very satisfactory, with the exception of some tendency to leak past seals on certain vehicles. In addition, there is some evidence of high ring-and-pinion gear wear in some types of axles. Ironically, although the field performance of this particular oil has been generally satisfactory, it will not pass the laboratory tests required for qualification under Military Specification MIL-L-2105. Nevertheless, based on the considerable experience which has been obtained over the past several years, a specification has been issued covering a sub-zero gear oil, MIL-L-10324, and covering physical requirements—but without the inclusion of specific performance tests. It is apparent that some means of evaluating gear oils of this nature must be developed in order to assure satisfactory performance of products in the field.

A possible future goal is the development of a single grade of gear oil, with extreme-pressure properties and viscosity characteristics, which will allow operation over the complete temperature range of —65° to +125° F.

"Balikpapan Hit Again," said the World War II headlines. Fuel and lubricant needs of our air arm are always under close study.

Present data indicate that, with the improvement of equipment items such as shift seals, it may be possible to accomplish this goal in the not too distant future.

Greases

At the present time there are approximately nine different greases used by the army for automotive and artillery equipment. Obviously, such a large variety of materials causes considerable complication in the field from the standpoint of supply—in addition to uncertainty that individuals responsible for maintenance will always use the correct material for each application. The reasons for this situation result from limitations both in equipment design and in the knowledge of the art of grease manufacture.

In the past it has been rather common practice to manufacture a special grease for each specific application where a particular performance factor demanded a certain characteristic. In many cases the individual greases were rather inflexible in their application because of narrow usable temperature range, low storage stability, poor volatility and oxidation-stability characteristics, poor water resistance, and resistance to structural changes at high shear rates.

Experimental materials with many desirable characteristics have been service-tested for several years under a wide variety of climatical conditions, and results have been quite satisfactory. On the basis of the data available, and on the known service characteristics required, an effort is now being made to prepare a specification which will cover a single all-temperature grade of grease to be used in all military automotive and artillery applications. This specification will replace some five specifications in the case of the army, and the advantages to be gained from the standpoint of supply and maintenance are manifold. For example, when a change in operation takes place from a temperate to an arctic zone, the time required for complete relubrication on a medium tank is approximately 250 man-hours, and the time for a 2½-ton truck is approximately 50 man-hours. These figures are based upon ideal conditions in a well-equipped shop, but facilities for this work in the field may be quite limited, and may impose an even greater problem. As an immediate goal, the following approximate characteristics seem desirable: dropping point, 300° F., minimum; worked penetration, 350, maximum; evaporation, 15 per cent, maximum, in 22 hours at 210° F. based on the ASTM test cell; separation, 4 percent, maximum, in 50 hours at 160° F.; oxidation stability, a maximum of 5-psi drop after 100 hours at 210° F. and 110-psi initial pressure. Other requirements will include satisfactory low-temperature characteristics, corrosion-preventive properties, water resistance, the ability satisfactorily to lubricate wheel bearings and reciprocating parts, and minimum thixotropic recovery after working.

Hydraulic Fluids

The several types of hydraulic systems presently in use in military equipment include artillery recoil systems, fire-control systems, shock absorbers, hydraulic brakes, and various power-transmission systems. In general, each system requires an independent development, and presents individual problems with respect to the working fluid. Low-temperature operational requirements reduce the number of types of usable materials, and indicate the need for a single fluid for all applications and all temperature conditions. Obviously, all present devices cannot be accommodated by one hydraulic fluid because of mechanical or material limitations, but these limitations can be determined, and suitable modifications to the working fluid can be made.

At the present time there is some lack of basic data on the limiting factors in the various systems. Currently work is progressing on such factors as: permissible viscosity ranges; the effect of high shear rates; the effect on wear rate, and on corrosion inhibition; oxidation stability; and the development of compatible elastomers used for seals.

For example, present materials which are capable of allowing satisfactory operation in certain systems at low temperatures may be completely

unsatisfactory in other applications for such reasons as shear stability, or perhaps the effect on rubber components of the system. It is felt that, when more data are available on the characteristics of the many systems and on the types of materials with the desirable physical characteristics, it will be possible to formulate a single hydraulic fluid capable of universal application for the various systems in existence. As may be expected in the development of improved materials, the rate of progress is often a function of progress in the development of related equipment and materials, and cannot be increased beyond a proportionate rate.

Corrosion Preventives

This is a field in which there are probably more different kinds of materials with overlapping applications than in any of the fields previously discussed and, at the same time, with very narrow ranges of usefulness. Part of this is probably the natural result of the general trend in the past toward the use of heavy petroleum-type compounds, the primary function of which seems to be to make it impossible to use the item being preserved without removal of the compound because the item cannot be operated with the material present. Most of these materials are highly satisfactory for specific applications, but have a high degree of inflexibility. For example, the use of the usual heavy rust-preventive compounds on a rifle is likely to assure good preservation. However, if it is necessary to put the rifle into use, considerable time must be wasted in cleaning the item. At the same time, should the prevailing temperature be low at the time of preparing the rifle for use, it becomes almost impossible to remove the compound by means other than the use of a blow torch or of hammer and chisel.

There is a very great need for the development of corrosion-preventive compounds with the ability to serve as a lubricant over wide temperature ranges, capable of relatively long-term preservation, requiring a minimum of time necessary for removal and re-preservation, and with sufficiently high viscosity and low volatility to prevent runoff and loss at elevated temperatures. A program is now under way to develop a material along these lines for the preservation of armament for limited periods of standby storage, but to be operable without removal of the preservative. A number of proposed preservatives look promising, but more research will be necessary to determine significant factors of corrosion preventives to give the foregoing desirable characteristics.

Summary

As with most materials used in the operation of military equipment, the technical requirements placed upon fuels and lubricants to meet the military performance standards are much more severe than requirements normally encountered for civilian usage. The characteristics or properties of fuels and lubricants in general which need further improvement to meet these military requirements are storage and oxidation stability. In addition, the following:

1) Gasolines, other than straight-run, need improved oxidation inhibitors and metal de-activators as well as the development of a means to predict storage stability.

2) Diesel fuels need improvement in compatibility, and better low-temperature characteristics.

3) Engine oils present the problems of unusual viscosity characteristics, high detergency, and freedom from formation of objectionable deposits—emphasized by fuels of higher sulfur content and increased amounts of cracked components.

4) Sub-zero engine oils need further development to reduce ring sticking, scuffing, and high rates of liner wear.

5) Gear oils should have better corrosion resistance, especially in the presence of moisture, and better methods must be developed for laboratory evaluations which can be correlated with service performance.

6) Greases need greater resistance to both physical and chemical changes, and must be capable of use under all climatic conditions.

7) Hydraulic fluids must have wider usable temperature ranges, and higher shear stability, to allow greater flexibility in application.

8) The development of one corrosion preventive of universal application would be ideal.

It is recognized that, even with the very fine research and development efforts of the petroleum industry, the ideal goals pointed out in this presentation are not likely to be achieved unless the equipment research and development are conducted concurrently, with the fullest interchange of ideas and information between the equipment designers and the petroleum industry. The Coordinating Research Council, Inc., is rendering an outstanding service to our national defense in conducting this coordination.

The army needs the help of the equipment manufacturers, and the help of the petroleum industry, in the solution of these problems. The current international situation has emphasized this need.

The American tanker fleet is typified here by the S.S.T.S. Peterson, Standard Oil Company of California 28,000-ton tanker.

THERMOCHEMISTRY for the Petrochemical Industry

Part XIV—Some Miscellaneous Hydrocarbons

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THE THERMODYNAMIC properties of groups of compounds have been presented in previous papers of this series as follow: paraffinic hydrocarbons,[4] mono-olefinic hydrocarbons,[5] cycloparaffinic hydrocarbons,[6] aromatic hydrocarbons,[7] acetylenic and diolefinic hydrocarbons,[8] combustion gases,[9] sulfur compounds,[10] halogens and halogen acids,[11] chloromethanes,[12] cyanogen compounds,[13] the oxides of nitrogen,[14] and some oxgenated hydrocarbons—C_1 and C_2.[15] Presented here are the data for some miscellaneous hydrocarbons—cyclopropane, isopentane, neopentane, o-xylene, m-xylene, and p-xylene.

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THE thermochemical data for the pentanes are of importance for isomerization calculations; n-pentane was previously discussed.[4] The formation of the ortho, meta, and para-xylenes in hydroforming operations is becoming of increasing importance, as is the chemical utilization of these compounds. Other aromatic compounds were reported previously.[7]

Table 1 summarizes the heat capacity determinations of cyclopropane, isopentane, neopentane, and the xylenes. The temperature range, method of derivation of the data, and reference are given in each case. It is noted that this group of compounds has not been the subject of extensive work.

The data presented for cyclopropane were derived from the data of Kistiakowsky and Rice,[2] whose values were calculated from spectroscopic data and agree closely with their four calorimetric check points. Linnett's values[16] were calculated from spectroscopic data also, but he used an incorrect frequency assignment. Kistiakowsky, Lacher, and Ransom[3] determined heat capacities by the bracketing method from heat conductances over a limited range. Stull and Mayfield[21] calculated the heat capacity by generalized bond frequency assignments at zero pressure. These data

Table 1
Reported Heat Capacity Data for Some Miscellaneous Hydrocarbons

Compound	Temperature Range	Method	Workers	Reference
Cyclopropane	250 to 1500° K.	Spectroscopic	Stull and Mayfield	21
	250 to 1500° K.	Spectroscopic	Stull	20
	100 to 1000° K.	Spectroscopic	Linnett	16
	157 to 340° K.	Calorimetric	Kistiakowsky, Lacher and Ransom	3
	272.15, 300.5, 333.7, and 366.5° K.	Calorimetric	Kistiakowsky and Rice	3
	100 to 1000° K.	Spectroscopic	Kistiakowsky and Rice	3
Isopentane	181° C.	Calorimetric	Eucken and Sarstedt	1
	58 and 100.75° C.	Calorimetric	Vogel	23
	298.16 to 1500° K.	Semi-empirical	Pitzer and Kilpatrick	17
Neopentane	298.16 to 1500° K.	Spectroscopic	Pitzer and Kilpatrick	17
o-Xylene	393, 428, and 463° K.	Calorimetric	Pitzer and Scott	18
	298.16 to 1500° K.	Spectroscopic	Pitzer and Scott	18
	298.16 to 1500° K.	Spectroscopic	Taylor, et al.	22
m-Xylene	393, 428, and 463° K.	Calorimetric	Pitzer and Scott	18
	298.16 to 1500° K.	Spectroscopic	Pitzer and Scott	18
	298.16 to 1500° K.	Spectroscopic	Taylor, et al.	22
p-Xylene	393, 428, and 463° K.	Calorimetric	Pitzer and Scott	18
	298.16 to 1500° K.	Spectroscopic	Pitzer and Scott	18
	298.16 to 1500° K.	Spectroscopic	Taylor, et al.	22

Table 2
Free Energies of Formation, Heats of Formation, Heats of Combustion, and Molecular Weights of Some Miscellaneous Hydrocarbons at 25° C.[1]

Compound	Molecular Weight	$-\Delta G°_f$, cal./g.-mole	$-\Delta H°_f$, cal./g.-mole	$-\Delta H°_c$, cal./g.-mole: H_2O (liq.), CO_2 (gas)	$-\Delta H°_c$, cal./g.-mole: H_2O (gas), CO_2 (gas)
Cyclopropane (g)	42.08	.....	—12,740	468,290	499,850
Neopentane (g)	72.15	3,640	39,670	777,370	840,490
Isopentane (g)	72.15	3,500	36,920	780,120	843,240
o-Xylene (g)	106.16	—29,177	—4,540	1,045,940	1,098,540
m-Xylene (g)	106.16	—28,405	—4,120	1,045,520	1,098,120
p-Xylene (g)	106.16	—28,952	—4,290	1,045,690	1,098,290

[1] $-\Delta H_c$ represents the heat evolved at 25° C. and constant pressure in the combustion of the compounds (in some indicated state) in gaseous oxygen to form the products indicated. All reactants and products are in their appropriate standard reference states.

$\Delta H°_f$ and $\Delta G°_f$ represent the changes in heat content (enthalpy) and free energy respectively, for the formation of the compounds in the indicated state from carbon, hydrogen and oxygen, with all reactants and products in appropriate standard reference states.

Table 3
Heat Capacities of Some Miscellaneous Hydrocarbons cal./g-mole · °C.

°C.	Cyclopropane	Isopentane	Neopentane	o-Xylene	m-Xylene	p-Xylene
0	12.18	26.72	26.87	29.52	28.11	28.03
18	13.02	28.22	28.46	31.19	29.83	29.64
25	13.37	28.83	29.07	31.85	30.49	30.32
100	17.02	34.95	35.00	38.68	37.58	37.29
200	21.58	42.42	43.12	47.06	46.21	45.92
300	25.28	48.76	49.65	54.25	53.74	53.38
400	28.30	54.11	55.10	60.31	59.94	59.62
500	30.82	58.09	59.07	65.41	65.15	64.87
600	33.01	62.43	63.50	69.75	69.56	69.32
700	34.94	66.06	66.95	73.45	73.32	73.10
800	....	69.04	69.91	76.63	76.53	76.35
900	....	71.65	72.43	79.36	79.28	79.12
1000	....	73.91	74.60	81.71	81.64	81.51
1100	....	75.89	76.56	83.74	83.69	83.57
1200	....	77.60	78.21	85.50	85.46	85.35

Table 4
Heat Capacities of Some Miscellaneous Hydrocarbons cal./g-mole · °K.

°K.	Cyclopropane	Isopentane	Neopentane	o-Xylene	m-Xylene	p-Xylene
273	12.18	26.72	26.87	29.52	28.11	28.03
291	13.02	28.22	28.46	31.19	29.83	29.64
298	13.37	28.83	29.07	31.85	30.49	30.32
300	13.44	28.97	29.21	32.02	30.66	30.49
400	16.31	37.05	37.55	41.03	40.05	39.70
500	22.65	44.23	45.00	49.11	48.43	48.06
600	26.15	50.28	51.21	55.96	55.51	55.16
700	29.02	55.41	56.40	61.76	61.43	61.12
800	31.45	59.80	60.78	66.68	66.41	66.14
900	33.57	63.60	64.55	70.80	70.63	70.39
1000	35.39	66.90	67.80	74.25	74.23	74.02
1100	....	69.80	70.62	77.40	77.21	77.13
1200	....	72.29	73.04	80.02	79.95	79.80
1300	....	74.47	75.15	82.26	82.22	82.09
1400	....	76.37	76.99	84.24	84.19	84.07
1500	....	78.01	78.60	85.93	85.89	85.79

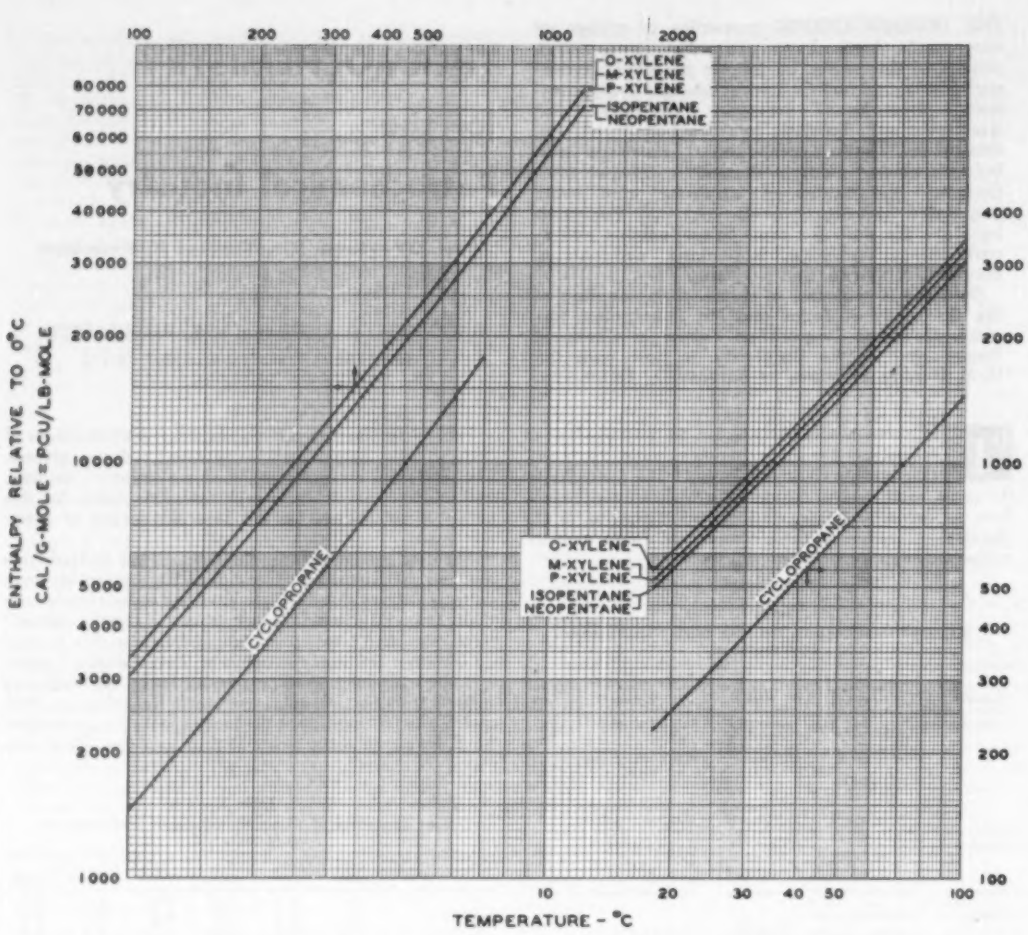

Figure 1 (above). Relative Enthalpies of Cyclopropane, Iso- and Neopentanes, o-, m-, and p-Xylenes.

Table 5
Heat Capacities of Some Miscellaneous Hydrocarbons
Btu/lb-mole · °F.

°F.	Cyclo-propane	Iso-pentane	Neo-pentane	o-Xylene	m-Xylene	p-Xylene
32	12.18	26.72	26.97	29.52	28.11	28.03
60	12.90	28.01	28.27	30.97	29.53	29.40
77	13.40	28.83	29.06	31.85	30.49	30.32
100	13.98	29.88	30.14	33.03	31.71	31.51
200	16.58	34.41	34.82	38.08	36.96	36.67
300	19.34	38.73	39.29	42.91	41.99	41.60
400	21.75	42.72	43.44	47.40	46.66	46.25
500	23.89	46.36	47.20	51.50	50.93	50.51
600	25.78	49.65	50.57	55.27	54.78	54.39
700	27.49	52.65	53.62	58.66	58.26	57.89
800	29.01	55.40	56.39	61.75	61.42	61.07
900	30.39	57.92	58.91	64.56	64.03	63.96
1000	31.68	60.24	61.22	67.13	66.91	66.59
1100	32.86	62.39	63.35	69.48	69.29	69.00
1200	33.98	64.37	65.31	71.63	71.47	71.20
1300	35.00	66.20	67.11	73.60	73.47	73.21
1400	....	67.90	68.78	75.42	75.31	75.06
1500	....	69.48	70.32	77.08	76.99	76.75
1600	....	70.93	71.74	78.61	78.53	78.31
1700	....	72.28	73.04	80.01	79.95	79.75
1800	....	73.54	74.24	81.31	81.25	81.06
1900	....	74.69	75.36	82.51	82.45	82.27
2000	....	75.76	76.40	83.61	83.56	83.39
2100	....	76.75	77.36	84.63	84.59	84.42
2200	....	77.67	78.26	85.57	85.53	85.37

are 20 percent higher than the data of Kistiakowsky and Rice. Stull[20] corrected the data of Stull and Mayfield to

Table 6
Heat Capacities of Some Miscellaneous Hydrocarbons
Btu/lb-mole · °R.

°R.	Cyclo-propane	Iso-pentane	Neo-pentane	o-Xylene	m-Xylene	p-Xylene
492	12.18	26.72	26.97	29.52	28.11	28.03
500	12.38	27.10	27.37	29.95	28.56	28.46
520	12.90	28.01	28.27	30.97	29.53	29.40
537	13.40	28.83	29.06	31.85	30.49	30.32
600	15.15	31.71	32.04	35.08	33.84	33.54
700	17.78	36.19	36.65	40.06	39.02	38.65
800	20.34	40.38	41.01	44.76	43.92	43.50
900	22.65	44.23	45.00	49.11	48.43	48.06
1000	24.67	47.73	48.60	53.06	52.53	52.10
1100	26.49	50.89	51.84	56.70	56.22	55.85
1200	28.12	53.79	54.77	59.94	59.58	59.21
1300	29.56	56.44	57.44	62.90	62.52	62.26
1400	30.93	58.86	59.87	65.62	65.17	65.02
1500	32.18	61.12	62.10	68.10	67.94	67.56
1600	33.34	63.21	64.16	70.37	70.19	69.90
1700	34 42	65.12	66.05	72.44	72.30	72.05
1800	35.40	66.90	67 80	74.35	74.23	74 02
1900	....	68.55	69.42	76.11	76.01	75.74
2000	....	70.12	70.91	77.71	77.63	77 42
2100	....	71.49	72.27	79.19	79 12	78 90
2200	....	72.80	73.53	80.55	80.49	80.30
2300	....	74.02	74.70	81.81	81.74	81.54
2400	....	75.13	75.79	82.96	82.91	82.73
2500	....	76.17	76.80	84.03	83.96	83.81
2600	....	77.13	77.73	85.02	84.98	84.80
2700	....	78.01	78.60	85.93	85.89	85.79

Table 7
Enthalpies of Some Miscellaneous Hydrocarbons
cal./g-mole

°C.	Cyclo-propane	Iso-pentane	Neo-pentane	o-Xylene	m-Xylene	p-Xylene
0	0.0	0.0	0.0	0.0	0.0	0.0
15	226.6	494.3	499.0	548.9	521.1	518.7
25	319.0	694.0	700.4	769.5	732.2	728.9
100	1,460	3,087	3,130	3,414	3,287	3,269
200	3,396	6,985	7,060	7,711	7,492	7,424
300	5,748	11,530	11,700	12,790	12,510	12,390
400	8,432	16,680	16,860	18,520	18,200	18,050
500	11,400	22,330	22,750	24,820	24,460	24,270
600	14,580	28,400	28,950	31,580	31,200	30,990
700	17,980	34,840	35,460	38,750	38,350	38,120
800	.....	41,600	42,280	46,230	45,850	45,600
900	.....	48,640	49,480	54,060	53,640	53,370
1000	.....	55,920	56,890	62,110	61,690	61,400
1100	.....	63,410	64,410	70,390	69,960	69,650
1200	.....	71,080	71,700	78,850	78,420	78,100

Table 8
Enthalpies of Some Miscellaneous Hydrocarbons
cal./g-mole

°K.	Cyclo-propane	Iso-pentane	Neo-pentane	o-Xylene	m-Xylene	p-Xylene
273	0.0	0.0	0.0	0.0	0.0	0.0
291	226.6	494.3	499.0	548.0	521.1	518.7
298	319.0	694.0	700.4	769.5	732.2	728.9
300	343.7	747.2	754.0	828.2	788.5	785.0
400	1,936	4,053	4,096	4,496	4,278	4,260
500	3,993	8,127	8,235	9,008	8,782	8,701
600	6,444	12,960	13,060	14,270	13,970	13,870
700	9,206	18,150	18,440	20,160	19,830	19,690
800	12,230	23,920	24,310	26,590	26,230	26,060
900	15,490	30,090	30,580	33,470	33,080	32,900
1000	18,940	36,620	37,200	40,730	40,330	40,130
1100	.....	43,460	44,120	48,320	47,910	47,690
1200	.....	50,570	51,310	56,200	55,780	55,540
1300	.....	57,910	58,720	64,310	63,890	63,640
1400	.....	65 451	66,330	72,640	72,210	71,950
1500	.....	73,170	74,110	81,150	80,720	80,450

Table 9
Enthalpies of Some Miscellaneous Hydrocarbons
Btu/lb-mole

°F.	Cyclo-propane	Iso-pentane	Neo-pentane	o-Xylene	m-Xylene	p-Xylene
32	0.0	0.0	0.0	0.0	0.0	0.0
60	351.2	766.2	773.4	847.1	807.7	803.6
77	574.2	1,249	1,260.7	1,385	1,318	1,312
100	889.1	1,924	1,941.5	2,131	2,033	2,022
200	2,424	5,160	5,191	5,668	5,468	5,430
300	4,224	8,800	8,899	9,740	9,415	9,345
400	6,298	12,880	13,040	14,280	13,850	13,740
500	8,574	17,330	17,570	19,210	18,740	18,580
600	11,070	22,140	22,460	24,580	24,030	23,820
700	13,740	27,250	27,680	30,250	29,680	29,440
800	16,550	32,660	33,180	36,270	35,670	35,390
900	19,530	38,320	38,950	42,580	41,940	41,640
1000	22,620	44,240	44,950	49,180	48,490	48,160
1100	25,840	50,370	51,180	56,010	55,300	54,940
1200	29,200	56,710	57,620	63,060	62,340	61,950
1300	32,660	63,240	64,240	70,330	69,590	69,180
1400	.....	69,940	71,040	77,780	77,030	76,590
1500	.....	76,810	77,990	85,410	84,650	84,180
1600	.....	83,840	85,100	93,190	92,420	91,940
1700	.....	91,000	92,340	101,120	100,330	99,840
1800	.....	98,290	99,700	109,190	108,410	107,880
1900	.....	105,700	107,190	117,380	116,600	116,040
2000	.....	113,220	114,770	125,690	124,900	124,330
2100	.....	120,850	122,460	134,100	133,300	132,720
2200	.....	128,570	130,360	142,630	141,810	141,210

one atmosphere pressure.

With the exception of three scattered values, the only data available on isopentane vapor are those presented by Pitzer and Kilpatrick.[17] They used an approximate method in which the values of the functions are based on the values of the normal isomer. Pitzer and Kilpatrick[17] are also the only source of data for neopentane. Spectroscopic

Figure 2 (below). Heat Capacity Curves for Cyclopropane, Iso- and Neopentanes, o-, m-, and p-Xylenes.

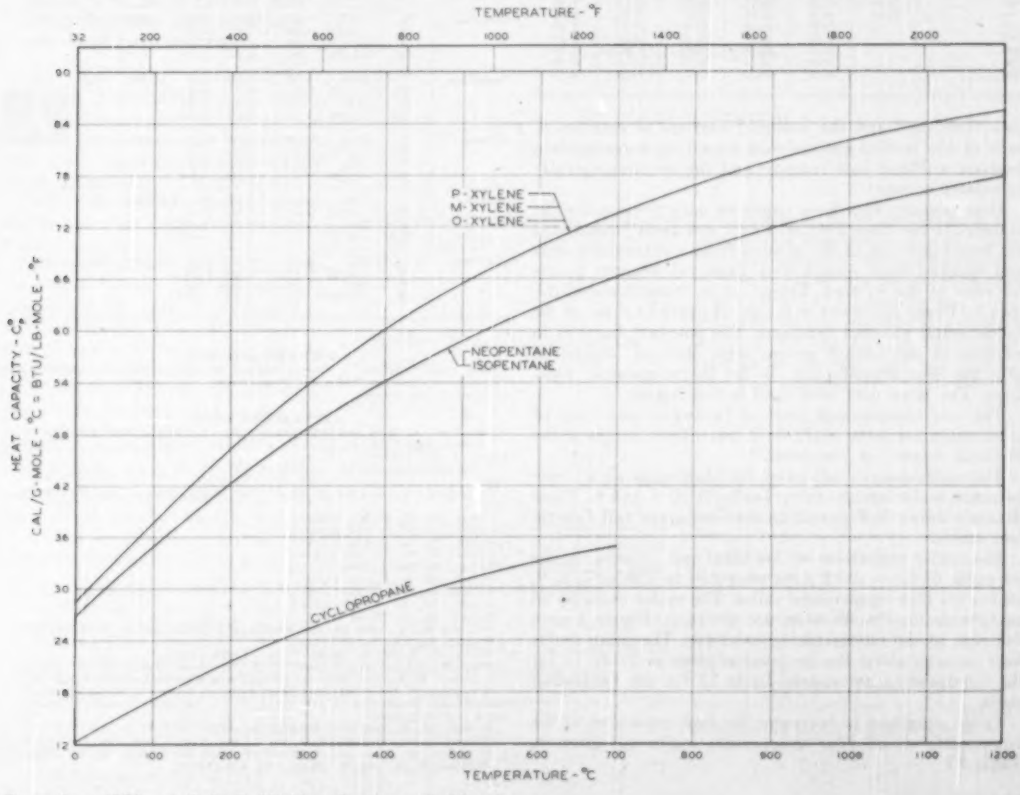

Table 10

Enthalpies of Some Miscellaneous Hydrocarbons

Btu/lb-mole

°R.	Cyclo-propane	Iso-pentane	Neo-pentane	o-Xylene	m-Xylene	p-Xylene
492	0.0	0.0	0.0	0.0	0.0	0.0
500	102.1	223.7	225.8	247.3	235.6	226.1
520	351.0	766.3	773.4	847.1	807.7	803.6
537	574.0	1,249	1,260.7	1,385	1,318	1,313
600	1,470	3,165	3,196	3,499	3,355	3,323
700	3,103	6,562	6,632	7,258	7,001	6,955
800	5,024	10,390	10,520	11,500	11,150	11,110
900	7,177	14,630	14,820	16,200	15,770	15,680
1000	9,550	19,230	19,500	21,310	20,820	20,690
1100	12,120	24,160	24,530	26,800	26,260	26,080
1200	14,850	29,400	29,863	32,610	32,060	31,830
1300	17,730	34,910	35,480	38,750	38,170	37,900
1400	20,760	40,680	41,340	45,190	44,550	44,260
1500	23,900	46,680	47,440	51,880	51,210	50,890
1600	27,180	52,900	53,760	58,810	58,120	57,780
1700	30,590	59,310	60,270	65,950	65,240	64,860
1800	34,090	65,920	66,960	73,290	72,570	72,170
1900	.....	72,690	73,820	80,810	80,080	79,660
2000	.....	79,620	80,840	88,510	87,770	87,310
2100	.....	86,710	88,000	96,350	95,610	95,130
2200	.....	93,920	95,290	104,340	103,590	103,090
2300	.....	101,260	102,700	112,460	111,700	111,180
2400	.....	108,720	110,230	120,700	119,930	119,390
2500	.....	116,280	117,860	129,050	128,280	127,720
2600	.....	123,950	125,590	137,500	136,730	136,150
2700	.....	131,710	133,400	146,050	145,300	144,810

Table 11

Mean Heat Capacities of Some Miscellaneous Hydrocarbons

cal./g-mole · °C.

°C.	Cyclo-propane	Iso-pentane	Neo-pentane	o-Xylene	m-Xylene	p-Xylene
0	12.18	26.72	26.87	29.52	28.11	28.03
18	12.59	27.46	27.72	30.49	28.95	28.82
25	12.76	27.76	28.02	30.78	29.29	29.18
100	14.60	30.87	31.30	34.14	32.87	32.69
200	16.98	34.82	35.30	38.56	37.46	37.12
300	19.16	38.43	39.00	42.63	41.69	41.30
400	21.08	41.70	42.15	46.30	45.50	45.12
500	22.80	44.66	45.50	49.64	48.92	48.54
600	24.30	47.33	48.25	52.63	52.00	51.65
700	25.41	49.76	50.66	55.36	54.79	54.46
800	.....	52.00	52.85	57.81	57.31	57.00
900	.....	54.04	54.98	60.05	59.60	59.30
1000	.....	55.92	56.89	62.11	61.69	61.40
1100	.....	57.65	58.55	63.99	63.60	63.32
1200	.....	59.23	59.75	65.71	65.35	65.08

data were used and the potential barriers to rotation of each of the methyl groups were found by a comparison between a Third Law entropy and the spectroscopically calculated entropy.

Heat capacity data have appeared only twice in the literature for the three xylenes. Pitzer and Scott[18] calculated the heat capacities of the xylenes from spectroscopic data and checked their results with three calorimetric points for each of the xylenes. Taylor, et al.,[22] recalculated the data of Pitzer and Scott with new improved values of the fundamental physical constants. The potential barriers to rotation of the methyl groups were changed slightly to give the best reproduction of the thermodynamic functions. The latest data were used in this report.

The free energies and heats of formation and heats of combustion are given in Table 2, taken from values of the National Bureau of Standards.[19]

The molar heat capacities of the ideal gases on all temperature scales are given in Tables 3, 4, 5 and 6. These data are shown in Figure 2 on the Centigrade and Fahrenheit scales.

The molar enthalpies of the ideal gas, relative to the ice point 0° C. = 32° F., are presented in Tables 7, 8, 9, 10 for all four temperature scales. The molar enthalpy in cal/g-mole, or Pcu/lb-mole, are shown in Figure 2 as a function of the Centigrade temperature. The mean molar heat capacity above the ice point is given in Table 11 for the Centigrade scale and in Table 12 for the Fahrenheit scale.

Cubic equations to represent the heat capacities of the compounds on all four temperature scales are given in Table 13.

Table 12

Mean Heat Capacities of Some Miscellaneous Hydrocarbons

Btu/lb-mole · °F.

°F.	Cyclo-propane	Iso-pentane	Neo-pentane	o-Xylene	m-Xylene	p-Xylene
32	12.18	26.72	26.87	29.52	28.11	28.03
60	12.54	27.37	27.62	30.25	28.85	28.70
77	12.76	27.76	28.02	30.78	29.29	29.18
100	13.08	28.29	28.55	31.34	29.90	29.75
200	14.45	30.60	30.90	33.86	32.55	32.32
300	15.76	32.84	33.21	36.34	35.14	34.87
400	16.99	35.00	35.43	38.75	37.68	37.34
500	18.32	37.03	37.54	41.05	40.04	39.71
600	19.49	38.98	39.54	43.22	42.30	41.95
700	20.57	40.79	41.44	45.28	44.43	44.07
800	21.55	42.53	43.20	47.23	46.45	46.08
900	22.50	44.15	44.87	49.07	48.32	47.97
1000	23.37	45.70	46.44	50.81	50.09	49.76
1100	24.19	47.16	47.92	52.44	51.78	51.45
1200	25.00	48.55	49.33	53.99	53.38	53.04
1300	25.76	49.87	50.66	55.47	54.88	54.56
1400	.....	51.13	51.93	56.86	56.31	55.90
1500	.....	52.32	53.13	58.18	57.66	57.16
1600	.....	53.47	54.27	59.43	58.94	58.63
1700	.....	54.56	55.36	60.62	60.16	59.86
1800	.....	55.59	56.39	61.76	61.32	61.02
1900	.....	56.58	57.38	62.84	62.42	62.12
2000	.....	57.53	58.32	63.87	63.46	63.17
2100	.....	58.44	59.22	64.85	64.46	64.18
2200	.....	59.30	60.07	65.78	65.41	65.13

Table 13

Heat Capacity Equations for Some Miscellaneous Hydrocarbons

Range: The equivalent of that indicated for the Centrigrade Scale.

Equation: $C^\circ_p = a + b(t) + c(t^2) + d(t^3)$

Units: cal./g-mole · °C. or °K.
Btu/lb.-mole · °F. or °R.

Compound	T	a	b.10²	c.10⁵	d.10⁸	Range	ERROR Max.%	ERROR Avg.%
Cyclopropane	°C.	12.09	5.508	−4.298	15.61	0-700	0.94	0.35
	°K.	−6.481	8.206	−5.577	15.61			
	°F.	11.10	3.146	−1.352	2.677			
	°R.	−6.481	4.559	−1.721	2.677			
Isopentane	°C.	26.72	8.912	−5.797	15.86	0-1200	0.34	0.14
	°K.	−2.273	12.434	−7.097	15.86			
	°F.	25.12	5.067	−1.815	2.719			
	°R.	−2.273	6.908	−2.190	2.719			
Neopentane	°C.	26.88	9.346	−6.475	18.83	0-1200	0.27	0.12
	°K.	−3.865	13.305	−8.018	18.83			
	°F.	25.20	5.321	−2.029	3.229			
	°R.	−3.865	7.392	−2.475	3.229			
o-Xylene	°C.	29.40	10.149	−6.812	18.80	0-1200	0.52	0.15
	°K.	−3.789	14.291	−8.354	18.80			
	°F.	27.57	5.774	−2.133	3.224			
	°R.	−3.789	7.940	−2.578	3.224			
m-Xylene	°C.	28.00	10.529	−7.188	20.05	0-1200	0.67	0.16
	°K.	−6.533	14.905	−8.831	20.05			
	°F.	26.11	5.993	−2.252	3.438			
	°R.	−6.533	8.280	−2.726	3.438			
p-Xylene	°C.	27.90	10.240	−6.588	17.03	0-1200	0.56	0.18
	°K.	−5.334	14.220	−7.984	17.03			
	°F.	26.08	5.820	−2.061	2.940			
	°R.	−5.334	7.900	−2.464	2.940			

ACKNOWLEDGMENT

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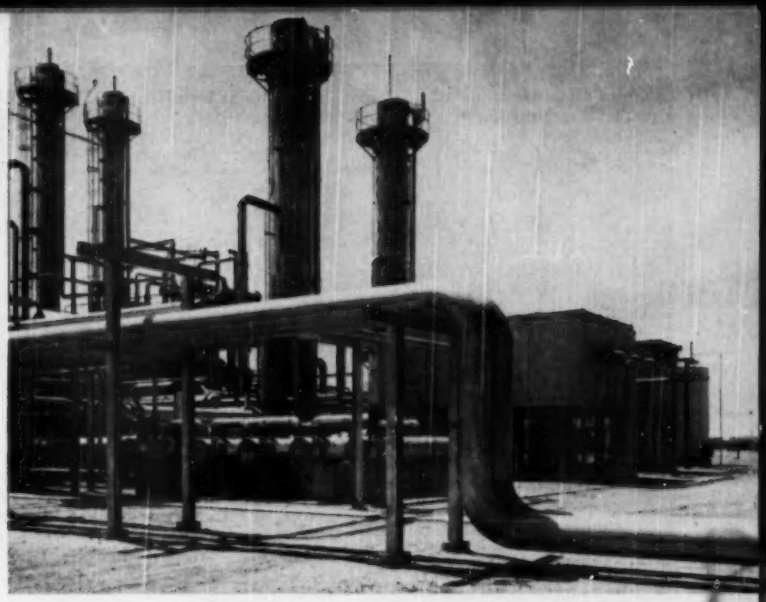

A portion of the process area in the Big Lake plant of Barsbart Hydrocarbon Corporation. The lean oil-rich oil exchangers are in the foreground beneath the cooling water lines.

THE AUTHOR has developed a system of light hydrocarbon process plant calculations that utilizes printed forms to expedite the work. Engineers do a great amount of trial-and-error work in setting up or checking the operation of hydrocarbon processing units. Much of this can be by-passed through the use of these forms. Prepared forms provide an orderly procedure for rating the major equipment items of a process and for making the usual absorption, stripping, fractionation, and vapor-liquid equilibria calculations.

Parts I and II, October and November Petroleum Refiner, treated the basic principles upon which light hydrocarbon process plant calculations and designs are based, and presented the first of the calculation forms. This Part III continues with these printed calculation forms and considers absorber calculations.

A System of Process Calculations For Light Hydrocarbons

Part III. Absorption

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AN ABSORBER is a device used to remove from the gas stream desirable constituents with a solvent. What has been learned about equilibrium in previous discussions can be applied directly to the analysis of what takes place in an absorber.

Mathematical analysis of most plate columns requires that the analysis start at the top, so it is customary to designate the top tray of such a column as tray 1. Any particular tray in the column under discussion is designated as tray n. The tray above the nth tray will be designated as tray n-1, and the tray below the nth tray would therefore be tray $n+1$.

If a section of an absorber is assumed as shown in Figure 9, a material balance around the nth tray can be set up. In this discussion the following nomenclature will be used:

V = mols of gas rising through the absorber
L = mols of liquid flowing downwards through the absorber
x and y will have their common meanings as used in equilibrium calculations.

The equation for equilibrium around the nth tray then becomes

$$Vy_{n+1} - Vy_n = Lx_n - Lx_{n-1} \quad (1)$$

Substituting in Equation 1 for the x's the relationship that $Y/K = X$, Equation 1 becomes:

$$Vy_{n+1} - Vy_n = \frac{L}{K} y_n - \frac{L}{K} y_{n-1} \quad (2)$$

Dividing Equation 2 through by V, we obtain:

$$y_{n+1} - y_n = \frac{L}{VK} y_n - \frac{L}{VK} y_{n-1} \quad (3)$$

Setting:

$$\frac{L}{VK} = A \quad (4)$$

and following the nomenclature of Kremser and Brown, call this the absorption factor. Substituting this value of L/VK, Equation 3 becomes:

$$y_{n+1} - y_n = Ay_n - Ay_{n-1} \quad (5)$$

Collecting the Y_n terms on to the left hand side of the equation:

$$y_n + Ay_n = y_{n+1} + Ay_{n-1} \quad (6)$$

then solving for y_n:

$$y_n = \frac{y_{n+1} + Ay_{n-1}}{A+1} \quad (7)$$

This then is the general equation for equilibrium around any tray and gives the composition of the gas leaving the tray in terms of the gas entering that tray and the gas leaving the tray above that tray. As this equation is a general equation for any tray in the column starting at the top and substituting $n = 1$ we can obtain:

$$y_1 = \frac{y_2 + Ay_0}{A+1} \quad (8)$$

This gives the composition of the gas leaving the top plate of the absorber in terms of the composition of the gas entering that tray, and the gas in equilibrium with a hypothetical tray above the top tray on which the exit gas is in equilibrium with any dissolved constituents remaining in the absorbent entering the top of the absorber.

Likewise the equation for the gas leaving the second tray is obtained by substituting in Equation 7, $n = 2$:

$$y_2 = \frac{y_3 + Ay_1}{A+1} \quad (9)$$

Substituting the value of y_1 from Equation 8 in Equation 9:

$$y_2 = \frac{y_2 + A\left(\frac{y_2 + Ay_3}{A+1}\right)}{A+1} \quad (10)$$

$$Ay_2 + y_2 = \frac{(A+1)y_2 + Ay_3 + A^2y_3}{A+1}$$

$$A^2y_2 + 2Ay_2 + y_2 = (A+1)y_2 + Ay_3 + A^2y_3$$

$$A^2y_2 + Ay_2 + y_2 = (A+1)y_2 + A^2y_3$$

$$y_2 = \frac{(A+1)y_2 + A^2y_3}{A^2 + A + 1} \quad (11)$$

Equation 11 gives the composition of the gas leaving the second tray of the absorber with respect to the gas entering the second tray and composition of the lean oil entering the absorber.

Substituting in Equation 7, $n = 3$:

$$y_3 = \frac{y_3 + Ay_4}{A+1} \quad (12)$$

Substituting value of y_2 from Equation 11 in Equation 12:

$$y_3 = \frac{y_3 + A\left[\frac{(A+1)y_3 + A^2y_4}{A^2 + A + 1}\right]}{A+1} \quad (13)$$

$$(A+1)y_3 = y_3 + A\left[\frac{(A+1)y_3 + A^2y_4}{A^2 + A + 1}\right]$$

$$(A+1)(A^2 + A + 1)y_3 = (A^2 + A + 1)y_3 + A^2y_3 + Ay_3 + A^3y_4$$

$$A^2y_3 + 2A^2y_3 - 2Ay_3 + y_3 = (A^2 + A + 1)y_4 + A^2y_3 + Ay_3 + A^3y_4$$

$$A^2y_3 + A^2y_3 + Ay_3 + y_3 = (A^2 + A + 1)y_4 + A^3y_4$$

$$y_3 = \frac{(A^2 + A + 1)y_4 + A^3y_4}{A^3 + A^2 + A + 1} \quad (14)$$

Equation 14 gives the composition of the vapor leaving the third tray in terms of the gas entering the third tray and the composition of the lean oil. By factoring, Equations 8, 11 and 14 can be written in the following forms:

$$y_1 = \frac{(A-1)y_2 + A(A-1)y_4}{A^2 - 1} \quad (15)$$

$$y_2 = \frac{(A^2-1)y_3 + A^2(A-1)y_4}{A^3 - 1} \quad (16)$$

$$y_3 = \frac{(A^3-1)y_4 + A^3(A-1)y_5}{A^4 - 1} \quad (17)$$

By the use of mathematical induction from Equations 15, 16 and 17, a general equation for n trays can be written as follows:

$$y_n = \frac{(A^n-1)y_{n+1} + A^n(A-1)y_0}{A^{n+1} - 1} \quad (18)$$

Taking a material balance over the whole absorber:

$$Vy_{n+1} - Vy_1 = LX_n - LX_0 \quad (19)$$

$$y_{n+1} - y_1 = Ay_n - Ay_0 \quad (20)$$

$$y_n = \frac{y_{n+1} - y_1 + Ay_0}{A} \quad (21)$$

and setting Equation 21 equal to Equation 18:

$$y_n = \frac{(A^n-1)y_{n+1} + A^n(A-1)y_0}{A^{n+1} - 1} = \frac{y_{n+1} - y_1 + Ay_0}{A} \quad (22)$$

Solving for y_1:

$$A(A^n-1)y_{n+1} + A^{n+1}(A-1)y_0 = (A^{n+1}-1)y_{n+1} - (A^{n+1}-1)y_1 + A(A^{n+1}-1)y_0$$

$$(A^{n+1}-1)y_1 = A^{n+1}y_{n+1} - y_{n+1} + A^{n+2}y_0 - Ay_0 - A^{n+1}y_{n+1} + Ay_{n+1} - A^{n+1}y_0 + A^{n+1}y_0$$

$$= -y_{n+1} + Ay_{n+1} - Ay_0 + A^{n+1}y_0$$

$$= (A-1)y_{n+1} + (A^{n+1} - A)y_0$$

$$y_1 = \frac{(A-1)y_{n+1} + A(A^n-1)y_0}{A^{n+1} - 1} \quad (23)$$

Equation 23 gives the composition of the gas leaving the absorber in terms of the gas entering the absorber and the gas in equilibrium on the hypothetical tray above the top tray. Equation 23 can be rewritten in the form:

$$y_1 = \left(\frac{A-1}{A^{n+1}-1}\right)y_{n+1} + \left(\frac{A^{n+1} - A}{A^{n+1} - 1}\right)y_0 \quad (24)$$

and as:

$$\frac{A-1}{A^{n+1}-1} = 1 - \frac{A^{n+1} - A}{A^{n+1} - 1} \quad (25)$$

and substituting this value of $\frac{A-1}{A^{n+1}-1}$ in Equation 24:

$$y_1 = y_{n+1} - \left(\frac{A^{n+1} - A}{A^{n+1} - 1}\right)y_{n+1} + \left(\frac{A^{n+1} - A}{A^{n+1} - 1}\right)y_0 \quad (26)$$

which can be rearranged to:

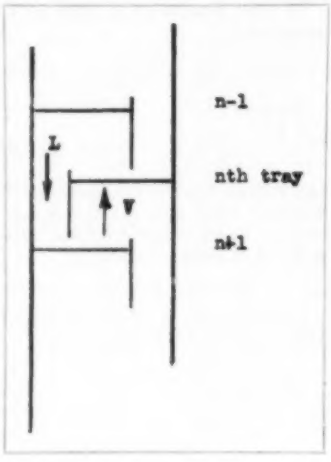
$$y_1 - y_{n+1} = \frac{A^{n+1} - A}{A^{n+1} - 1}(y_0 - y_{n+1}) \quad (27)$$

Dividing both sides of Equation 27 by $y_0 - y_{n+1}$:

$$\frac{y_1 - y_{n+1}}{y_0 - y_{n+1}} = \frac{A^{n+1} - A}{A^{n+1} - 1} \quad (28)$$

which can be rearranged to:

Figure 9



$$\frac{y_{n+1} - y_1}{y_{n+1} - y_0} = \frac{A^{n+1} - A}{A^{n+1} - 1} \quad (29)$$

$y_{n+1} - y_1$ is the extraction that will actually take place in the absorber. $y_{n+1} - y_0$ is the extraction that takes place if the exit gas were in equilibrium with the entering oil. Therefore, the expression $\frac{y_{n+1} - y_1}{y_{n+1} - y_0}$ is the efficiency of the absorber and as such can be plotted against different values of A and number of trays obtaining a family of curves as shown in Figure 10.

Analyzing Figure 10 for its physical significance discloses another interesting and useful relationship. Considering the absorption factor required for any given extraction for a component under consideration for any given number of trays, as compared to the absorption factor required if an infinite number of trays were used, and remembering that A is a function of the ratio of vapor to liquid mols it is seen that the ratio between the A for infinite number of trays and A required to give that extraction is the approach to equilibrium of that constituent in the liquid leaving the base of the absorber.

A plot of this relationship is given in Figure 11.

The absorption factor A can also be plotted on this curve. The absorption factor plot is a family of straight lines radiating from zero percent extraction and zero percent equilibrium.

From this curve the absorption factor of any constituent for any percent extraction with the desired or given number of theoretical trays can be used. The absorption factor for any other constituent is obtained by the simple relationship

$$A_1 = A\frac{K}{K_1}$$

When A_1 = Absorption Factor of desired constituent
A = Absorption Factor of key constituent
K_1 = Equilibrium Constant of desired constituent
K = Equilibrium Constant of key constituent

Then having the absorption factor of the other constituents their percent extractions and percent equilibrium can be read from the curve.

In the plate-by-plate analysis of an absorber given above it was assumed for mathematical simplicity that the number of mols of vapor entering the absorber equals the number of mols leaving the absorber and likewise the mols of oil leaving the absorber equals the number of mols entering the absorber. This condition is only approached in practice when operating at very low pressures and with very

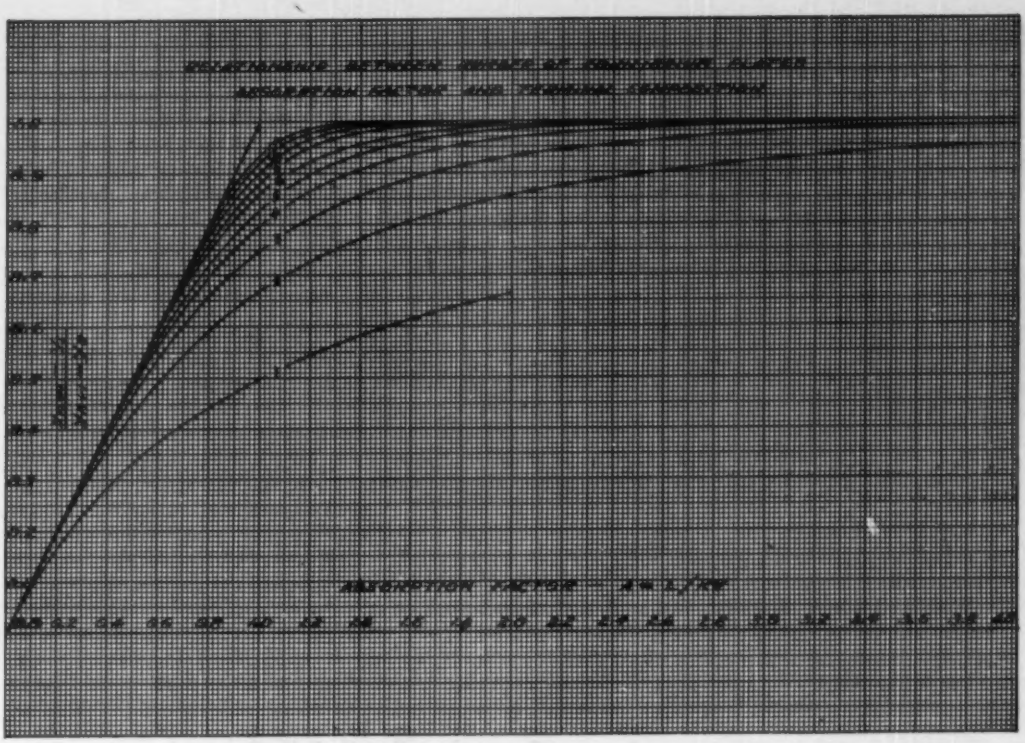


Figure 10. Relationship between Number of Equilibrium Plates Absorption Factor and Terminal Composition.

lean gases. This does not destroy the value of the analysis when we use the relationship as plotted in Figure 11. By concentrating on one point in the absorber where under any conditions of operation the change of the liquid and vapor mols for this point would be negligible with respect to the total number of mols of vapor or liquid entering and leaving, no serious error is introduced.

From a study of the above relationship it is apparent that the temperature and pressure conditions at the base of the absorber which is the first point of contact of the gas with the liquid is the most important point in the absorber to consider, and if equilibrium conditions for the number of trays in the absorber are satisfied at the base of the absorber the balance of the absorber will automatically take care of itself, provided that some higher point in the absorber is not at a much higher temperature. If this condition does exist it usually pays to use intercoolers to remove the heat of absorption.

There is another method of mathematical analysis of the action that takes place in an absorber that results in far more complicated mathematical formulae than that previously given, but is included in the present discussion for the purpose of completeness and also because certain of these formulae are used in determining the correct location of intercoolers in an absorber.

In this analysis it is assumed that the rate of change of liquid mol flowing down the absorber is the same for every plate and that the same law of rate of change of the number of gas mols holds. With this assumption a balance for any constituent on any tray of the absorber can be set up:

$$VR^{\frac{m-n}{m}} y_{n+1} - VR^{\frac{m-(n-1)}{m}} y_n = Lr^{\frac{n}{m}} x_n - Lr^{\frac{n-1}{m}} x_{n-1} \qquad (1)$$

where

V = mols of gas entering absorber
L = mols liquid entering absorber
R = mols gas leaving absorber divided by mols gas entering absorber
r = mols oil leaving absorber divided by mols oil entering absorber
m = total number of plates in absorber
n = plate under consideration
y = mol fraction of constituent in vapor phase
x = mol fraction of constituent in liquid phase

Using the same system as proposed by Dr. Brown and setting

$$K = \frac{y}{x}$$

$$\text{and } A = \frac{L}{VK}$$

then

$$R^{\frac{m-n}{m}} y_{n+1} - R^{\frac{m-(n-1)}{m}} y_n = Ar^{\frac{n}{m}} y_n - Ar^{\frac{n-1}{m}} y_{n-1}$$

and solving for y_n

$$y_n = \frac{R^{\frac{m-n}{m}} y_{n+1} + Ar^{\frac{n-1}{m}} y_{n-1}}{R^{\frac{m-(n-1)}{m}} + Ar^{\frac{n}{m}}} \qquad (2)$$

The composition of the gas leaving any absorber would then be where n = 1

$$y_1 = \frac{R^{\frac{m-1}{m}} y_2 + Ay_0}{R + Ar^{\frac{1}{m}}} \qquad (3)$$

The term $\frac{Ay_0}{R + Ar^{\frac{1}{m}}}$ represents the amount of any constituent added to the gas due to the absorbing medium

not being free of that constituent.

The composition of the gas leaving the second tray of the absorber would be

$$y_2 = \frac{R^{\frac{m-2}{m}} y_2 + Ar^{\frac{1}{m}} y_1}{R^{\frac{m-1}{m}} + Ar^{\frac{1}{m}}} \quad (4)$$

$$y_2 = \frac{\left(R^{\frac{2m-2}{m}} + Ar^{\frac{1}{m}} R^{\frac{m-2}{m}}\right) y_2 + A^2 r^{\frac{1}{m}} y_0}{R^{\frac{2m-1}{m}} + Ar^{\frac{1}{m}} R + A^2 r^{\frac{1}{m}}} \quad (5)$$

In like manner the composition of gas leaving any plate can be obtained

$$y_4 = \frac{R^{\frac{m-2}{m}}\left(R^{\frac{2m-1}{m}} + Ar^{\frac{1}{m}} R + A^2 r^{\frac{1}{m}}\right) y_4 + A^3 r^{\frac{1}{m}} y_0}{R^{\frac{3m-3}{m}} + Ar^{\frac{1}{m}} R^{\frac{2m-2}{m}} + A^2 r^{\frac{1}{m}} R^{\frac{m-1}{m}} + A^3 r^{\frac{1}{m}}} \quad (6)$$

$$y_5 = \frac{R^{\frac{m-1}{m}}\left(R^{\frac{3m-3}{m}} + Ar^{\frac{1}{m}} R^{\frac{2m-1}{m}} + A^2 r^{\frac{1}{m}} R + A^3 r^{\frac{1}{m}}\right) y_5 + A^4 r^{\frac{1}{m}} y_0}{R^{\frac{4m-4}{m}} + Ar^{\frac{1}{m}} R^{\frac{3m-2}{m}} + A^2 r^{\frac{1}{m}} R^{\frac{2m-1}{m}} + A^3 r^{\frac{1}{m}} R + A^4 r^{\frac{1}{m}}} \quad (7)$$

$$y_6 = \frac{R^{\frac{m-1}{m}}\left(R^{\frac{4m-4}{m}} + Ar^{\frac{1}{m}} R^{\frac{3m-2}{m}} + A^2 r^{\frac{1}{m}} R^{\frac{2m-1}{m}} + A^3 r^{\frac{1}{m}} R + A^4 r^{\frac{1}{m}}\right) y_6 + A^5 r^{\frac{1}{m}} y_0}{R^{\frac{5m-5}{m}} + Ar^{\frac{1}{m}} R^{\frac{4m-3}{m}} + A^2 r^{\frac{1}{m}} R^{\frac{3m-2}{m}} + A^3 r^{\frac{1}{m}} R^{\frac{2m-1}{m}} + A^4 r^{\frac{1}{m}} R + A^5 r^{\frac{1}{m}}} \quad (8)$$

Substituting the value of y_1 in Equation 3 and in Equation 4

We are interested in the relative amount of any constituent absorbed in the absorber and not particularly the composition of the gas from any particular plate in that absorber.

Then taking the material balance over the whole absorber

$$Vy_{m+1} - RVy_1 = Lrx_m - Lx_0 \quad (9)$$

$$y_{m+1} - Ry_1 = Ary_m - Ay_0 \quad (10)$$

The actual extraction of the absorber is expressed by the left hand term of Equation 10. The maximum extraction of any absorber would be where the exit gas was in equilibrium with the entering liquid and would be expressed by $y_m + 1 - Ry_0$.

Then the efficiency of the absorber would be

$$\frac{y_{m+1} - Ry_1}{y_{m+1} - Ry_0} = \frac{Ary_m - Ay_0}{y_{m+1} - Ry_0}$$

In any modern gasoline absorption plant the amounts of the light constituents, to and including pentane left in the lean oil, are practically zero. Therefore

$$x_0 = 0$$

and consequently $y_0 = 0$

Equation 11 then becomes

$$\frac{y_{m+1} - Ry_1}{y_{m+1}} = \frac{Ary_m}{y_{m+1}}$$

In a one plate absorber $m = 1$. Substituting $m = 1$ in Equations 3 and 12

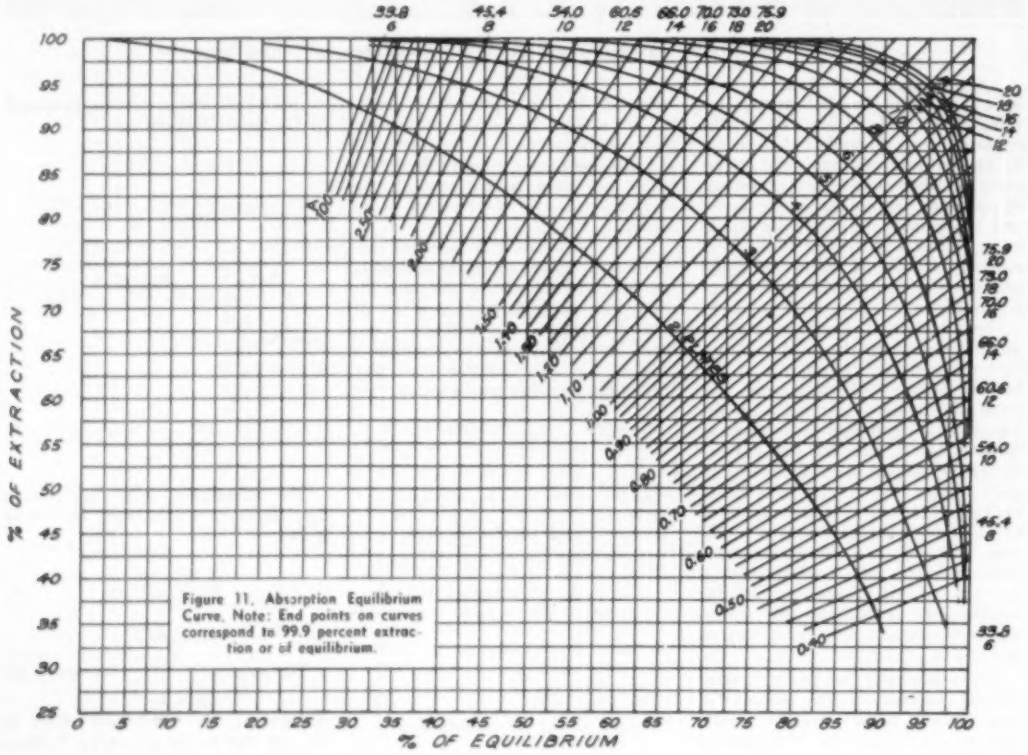
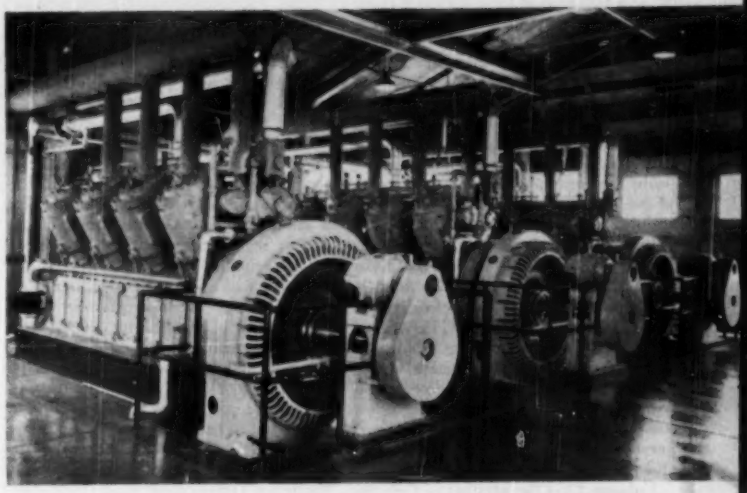


Figure 11. Absorption Equilibrium Curve. Note: End points on curves correspond to 99.9 percent extraction or of equilibrium.



Gas-engine driven electric power generators in Barnhart Hydrocarbon Corporation's Big Lake plant. The eight-cylinder V-angle engines deliver 375 hp. The generators are rated at 250 kw.

and substituting the value of y_1 from Equation 3 in Equation 12 and remembering that y_o in Equation 3 is zero.

$$\frac{y_2 - Ry_1}{y_2} = \frac{Ar}{R + Ar}$$

$$\frac{1}{\text{Efficiency}} = \frac{y_2}{y_2 - Ry_1} = \frac{R}{Ar} + 1 \qquad (13)$$

Similarly for a two plate absorber

$$\frac{1}{\text{Efficiency}} = \frac{y_3}{y_3 - Ry_2} = \frac{R^{3/2}}{Ar\,(R + Ar^{1/2})} + 1 \qquad (14)$$

For a three plate absorber

$$\frac{1}{\text{Efficiency}} = \frac{y_4}{} = \frac{R^2}{Ar\,(R^{3/3} + ARr^{2/3} + A^2r)} + 1 \qquad (15)$$

For a four plate absorber

$$\frac{1}{\text{Efficiency}} = \frac{y_5}{y_5 - Ry_4} = \frac{R^{\frac{5}{2}}}{Ar\left(R^{\frac{6}{4}} + AR^{\frac{4}{4}}r^{\frac{2}{4}} + A^2Rr^{\frac{3}{4}} + A^3r^{\frac{6}{4}}\right)} + 1 \qquad (16)$$

For a five plate absorber

$$\frac{1}{\text{Efficiency}} = \frac{y_6}{y_6 - Ry_5} = \frac{R^3}{Ar\left(R^{\frac{10}{6}} + AR^{\frac{8}{5}}r^{\frac{4}{5}} + A^2R^{\frac{6}{5}}r^{\frac{2}{5}} + A^3Rr^{\frac{6}{5}} + A^4r^3\right)} + 1 \qquad (17)$$

From these last five equations we can determine the series the denomination takes and write the equation of the efficiency for any number of plates. One over the efficiency of an absorber having m plates is then

$$\frac{1}{\text{Efficiency}} = \frac{y_{m+1}}{y_{m+1} - Ry_1} = \frac{R^{\frac{m+1}{2}}}{Ar\left(R^{\frac{2+\ldots m}{m}} + AR^{\frac{3+\ldots m}{m}}r^{\frac{m-1}{m}} + A^2R^{\frac{4+\ldots m}{m}}r^{\frac{2m-2}{m}} + A^3R^{\frac{5+\ldots m}{m}}r^{\frac{3m-6}{m}} + A^4R^{\frac{6+\ldots m}{m}}r^{\frac{4m-12}{m}} \ldots\right)} + 1$$

$2+\ldots m$ means the sum of all whole numbers from 2 to m, $3+\ldots m$ the sum of all whole numbers from 3 to m, etc.

The exponent of r starts with $\frac{m-1}{m}$ the coefficient of m in the numerator increases one in each succeeding term, the constant term is the coefficient of m in that term plus the constant term in the coefficient of the next preceding term.

In using this method of analysis to determine the proper location of intercoolers the general form of Equation 2 is used together with data obtained by the overall method given in detail later. From the determination of the oil rate and extractions desired the values of R, r, and m are computed.

These would be

R = Mols gas leaving absorber / Mols gas entering absorber

r = Mols rich oil leaving absorber / Mols lean oil entering absorber

m = Theoretical trays in the absorber

Then for the top plate Equation 3, which is Equation 2 where $n = 1$, is used assuming that Ay_o is zero. To solve this equation put y_1 equal to the mol fraction of each constituent in the residue gas and solve for y_2, the mol fraction of that constituent in the gas entering that tray. $VR\frac{m-1}{m}$ is the number of mols of gas entering the tray, and VR is the mols leaving. The number of mols of each constituent absorbed on that tray is then:

$$V\left(R^{\frac{m-1}{m}} - R\right)\left(y_2 - y_1\right)$$

Then using the values of the y_2's so calculated the value of the y_3's the value of $R^{\frac{m-1}{m}}$ and the number of mols of each constituent absorbed are computed, the total mols absorbed on this tray being

$$V\left(R^{\frac{m-1}{m}} - R^{\frac{m-2}{m}}\right)$$

From this data the heat of absorption on each tray is calculated. This calculation is continued until the total heats of absorption so calculated equal the heat required to be removed by the intercooler. When this point is reached the feed to the intercooler should be taken from the actual tray corresponding to the theoretical tray so calculated. In some cases more than one intercooler is required. The calculation is then continued below the top intercooler in the same manner as already given.

In order to use the method and curves developed it must be kept in mind that we are primarily interested in the equilibrium conditions that exist at the base of the absorber.

Normally the oil rate for an absorber is required to remove a definite percentage of one of the constituents that is considered the "key component." From the inlet gas analysis and quantity of gas to be treated the number of mols of the key component is known. A table such as shown on the "Absorption Calculations" form, Figure 12, is convenient for this calculation.

The basic data on the absorber is put in at the top of the form with the total inlet gas shown in Column 5 with the mol percents in Column 6. Column 8 is for the K's of the constituents at the absorber pressure and

assumed bottom temperature. Normally only the *K's* for the key component and lighter need be included if the percent recovery of the key component is relatively high, in which case the extractions of all components heavier than the key will be substantially 100 percent. If there is any doubt the next heavier component can be checked.

Column 9 is Column 6 divided by Column 8 and shows the composition of the lean oil with respect to these components for an absorber having an infinite number of theoretical trays. Column 10 gives the desired extraction of the key component. From this figure and the number of theoretical trays the *A*, absorption factor is determined from Figure 11. The *A* for the other components is thus calculated and their percent equilibriums read off the curve and put in Column 12.

Column 13 is the product of Column 9 and Column 12 and is the actual composition of the rich oil from the absorber at the operating pressure and assumed bottom temperature.

Column 14 gives the number of mols of the key component desired and is the product of the number of mols of key component in Column 5 and the percent of key component desired as shown in Column 10.

Next calculate the number of mols of fat oil leaving the absorber. The formula for this calculation is given on the right hand side of the sheet just below the data discussed above.

Column 16 is the total mols of fat oil times the percentages as shown in Column 13 divided by 100. These are the actual mols absorbed. It is to be noted that all components that are substantially 100 percent absorbed are less than at equilibrium at the base of the absorber so only the actual number of mols of these constituents shown in Column 5 are put in Column 16.

The number of mols of lean oil required will then be the mols of fat oil less the sum of the constituent absorbed in the fat oil. The mol percents in Column 17 should be the same as the mol percents in Column 13 for the key and lighter components.

The rest of the form and the heat balance are self explanatory. If no intercooler is used the sum of the "Heat to Lean Gas" and "Heat to L. O." should equal the "Heat of Abs." If not a new bottom temperature must be assumed and the calculation repeated.

The number of tray to use in an absorber is a matter largely of judgment influenced by the extraction of the key component required, the size of the plant and the gas analysis. By a study of the curve in Figure 11, it can be readily seen that as the number of trays in the absorber increases, the selectivity of absorption also increases. By selectivity of absorption is meant the amount of the heavier constituents absorbed with respect to the lighter constituents. Selectivity of absorption is also increased as the temperature of absorption decreases. As the number of trays increases the relative increase in selectivity with added trays decreases. Therefore, it is necessary to figure an approximate economical balance between the cost of the absorber, the oil rate as it effects the cost of the balance of the plant and the operating cost of the plant in order to determine exactly the number of trays. As a general rule it is better to err on the side of too many trays in an absorber than insufficient trays.

We have covered now the theory and its application to an absorber where we are removing material from the vapor phase by a liquid absorbent.

It is often necessary to compute what absorption would take place when the oil rate and gas volume are fixed in a given absorber. This would be in the cases of checking the efficiency of an absorber, determining what advantage could be gained by changing the oil rate in a plant by a given amount and in reworking an old plant for new conditions.

This involves a cut-and-try method. As in all cut-and-try methods experience is the only guide to a close approximation on the first guess. One method of getting a close approximation on the first guess is to calculate the absorber for several different extraction efficiencies and then from this information some guide is obtained for the first approximation.

With a known amount of oil available the basic absorbing material is known. To this must be added the constituents absorbed in order to arrive at the total quantity of material leaving the base of the absorber. The material leaving the base of the absorber must satisfy the conditions of the "corrected x" as calculated for the absorber.

If there is sufficient oil to absorb all the isopentane and heavier, the total base absorbing material can be considered as the sum of the oil plus the isopentane plus fractions. Next assume a n-butane extraction efficiency and from this look up on the curve, Figure 11, the absorption factor and percent equilibrium. From this data and the *K* for n-butane and the gas analysis compute the total mols of fat oil necessary. From the *K* of n-butane and the *K* of the other constituents compute the absorption factors of the other constituents and then by the use of the curve, Figure 11, determine the percent recovery and approach to equilibrium of these constituents and the number of mols of each absorbed. The sum of these constituents plus the mols of lean oil and isopentane plus must equal the mols of fat oil calculated from the assumed extraction of n-butane.

An example will show more clearly how this calculation is made and a table that is convenient for the calculation:

Absorber pressure	150 psig.
Lean oil temperature	60° F.
Rich gas temperature	80° F.
Lean oil mol weight	180
Lean oil density	42° API
Lean oil gal./mol	26.55
Assumed temperature rise	20° F. (using intercoolers)
Theoretical trays	12
Mols lean oil	1250
gas mols	15,138

Gas analysis:

	Percent	Mols.
C_1	36.83	5,576
C_2	28.84	4,366
C_3	23.58	3,569
C_4	4.21	637
C_4	4.64	702
C_5	.98	149
C_5	.66	100
C_6	.26	39
	100.00	15,138

As this is a very rich gas and the temperature level of absorption is low due to the use of intercoolers, the number of mols of the lighter constituents will be large making the total mols of fat oil three or four times the mols of lean oil indicating a high recovery of n-butane.

A convenient table for this calculation can be set up as per Table A, at left.

Assuming 95 percent n-butane absorption. The procedure in setting up this table is as follows: The gas com-

Table A

	Percent	K	x Equilib.	Percent Absorbed	A	Percent Equilib.	Corr. x	Assumed Mols. Absorbed	Calc. Mols. Absorbed
C_1	36.83	23	1.00	1.72	.0172	100	1.60	96	99
C_2	28.84	3.1	9.30	9.85	.0985	100	9.30	406	396
C_3	23.58	.95	24.82	32.10	.321	100	24.82	1145	1059
C_4	4.21	.37	11.39	80.7	.825	98.2	11.17	514	475
C_4	4.64	.27	17.20	95	1.13	89.2	15.33	665	665
	.....	.....	.....	.....	.....	.....	.....	2816	2664

position, the K's and x equilibrium for all constituents are set up. Then the assumed percent absorption of n-butane is put in and from the curves the absorption factor and percent equilibrium. The "corrected x" is entered and the number of mols assumed of n-butane are entered in the columns "Assumed Mols Absorbed" and "Calculated Mols Absorbed." Next from the absorption factor of n-butane compute the absorption factors of the other constituents and from these values and the curves "Percent Absorbed" and "Percent Equilibrium" and compute the "corrected x." From the mols of each constituent and the "Percent absorbed" fill in column "Assumed Mols Absorbed."

The total mols of rich oil necessary to absorb the 95 percent of the n-butane is

$$\frac{665 \times 100}{15.33} = 4260$$

With this value of 4260 and the "corrected x" compute the actual mols absorbed with this quantity of rich oil and enter in column "Calculated Mols Absorbed." As we had 1250 mols of lean oil, 288 mols of isopentane and heavier and 2664 mols of n-butane and lighter the calculated fat oil would be 4202. As this is less than the calculated necessary quantity of 4260 mols, the assumed extraction of 95 percent n-butane is too high. Likewise the columns "Assumed Mols Absorbed" and "Calculated Mols Absorbed" do not check. For the next assumption try 90 percent n-butane absorption. See Table B, below.

The calculation assuming 95 percent n-butane recovery required 58 mols

ABSORPTION CALCULATIONS

Date: 11-8-47
Process Sheet: 5
Preliminary
Final: X
By: A.B.C.
640

Customer: X.Y.Z. COMPANY — Inquiry No.
Service: Main Abs. — Job No.
Based on: Process Sheet 2 — By: A.B.C. — Dated: 11-4-47

Absorber Press.	900 psig	Lean Oil Temp.	90 °F	Rich Gas Temp.	90 °F		
Lean Oil:	230 MW	Sp. Gr.	38.5	°API	33.17	Gal./Mol.	
Extraction	88 % C_3	Assumed Temp. Rise	10 °F	Bottom Temp.	100 °F		
Actual Trays	32	Tray Efficiency	50 %	Theoretical Trays	16		

Sheet Col.					* Total Mols	* Mol %	* Pounds	* K 100°F	* X Equil.	* % Keys Desired	A	* % Equil.	* % X	* Corr. X	* Mols. Keys Desired
1	CO_2				5,883	2.58	258,852	1.15	2.24			100	2.24		
2	C_1				397,638	86.72	3,162,208	4.8	18.07			100	18.07		
3	C_2				14,182	6.22	425,434	.78	7.97			.473	100	7.97	
4	C_3				5,248	2.30	230,912	.41	5.61	88	.90	97.7	5.05	4.618	
5	C_{4A}				950	.42	55,100	.19	3.02	100	1.94				
6	C_4				1,668	.73	96,744	.348	4.93	100	2.49				
7	C_{5A}				535	.23	38,520								
8	C_5				736	.32	52,992								
9	C_6				629	.28	54,094								
10	P_1				153	.07	15,300								
11	P_2				122	.05	13,786								
12	P_3				156	.07	21,060								
13	P_4				3		600								
14	P_5														
15															
Total					2279039.99		4,425,602								

	* Mols Inlet	* Mols Absorbed	* Mol %	* Pounds	* Gallons	* Mols Residue	* Mol %	* Pounds
1		2048		90112	8868	3835		168740
2		16524		264384	105754	181114		2897824
3		7288		218614	70256	6894		206820
4		4618		203192	48073	630		27720
5		950		55100	11761			
6		1668		96744	19916			
7		535		38520	7604			
8		736		52992	10091			
9		629		54094	9094			
10		153		15300	2518			
11		122		13786	2222			
12		156		21060	3296			
13		3		600	88			
14								
15								
Tot.		35430		1124498	300043	192473		3301104
L.O.		56016		12883680	1858051			
F.O.		91446		14008174	2158092			

Fat Oil
= Mols Key Desired (100) / Corr. X Key
= 4.618 (100) / 5.05
F.O. = 91,446 Mols

Inlet Gas
86,375 MSCF/Day
.670 Sp. Gr. (Air = 1.0)

Residue Gas
72,947 MSCF/Day
.596 Sp. Gr. (Air = 1.0)

Fat Oil
1,430 GPM
.779 Sp. Gr.

Dissolved Const.
.45 Sp. Gr.
Mol. Wt. 31.7

HEAT BALANCE

Heat of Abs. = Lbs. Abs./24 (Rich Gas Ent. Temp. − Rich Gas Lean Temp.) = 1,124,498/24 (150 − 65) = 3,985,505 BTU/Hr.

Heat to L.O. = Lbs. L.O./24 (Rich Oil Rich Temp. − Rich Oil L.O. Temp.) = 12,883,680/24 (10 x .48 / 4.8) = 2,576,736

Assumed Lean Gas Temp. = °F

Heat to Lean Gas = Lbs. Lean Gas/24 (Rich Gas Abs. & Dist. Temp. − Rich Gas Rich Gas Temp.) = 3,301,104/24 (10 x .56) = 770,258

Heat to Lean Oil + Heat to Lean Gas = 3,346,994.

Intercooler Heat Load = BTU/Hr.

Table B

	Percent	K	x Equilib.	Percent Absorbed	A	Percent Equilib.	Corr. x	Assumed Mols. Absorbed	Calc. Mols. Absorbed
C_1	36.83	23	1.60	1.12	.0112	100	1.60	62	62
C_2	28.84	3.1	9.30	8.27	.0827	100	9.30	361	362
C_3	23.58	.95	24.82	27.0	.27	100	24.82	886	970
C_4	4.21	.37	11.35	60.0	.603	90.5	11.36	439	443
C_4	4.64	.27	17.20	90	.95	94.4	16.20	632	632
	.....	.....	.....	.....	.....	.....	.....	.....	2469

$$\text{Mols fat oil necessary} = \frac{632 \times 100}{16.20} = 3900$$

Table C

	Percent	K	x Equilib.	Percent Absorbed	A	Percent Equilib.	Corr. x	Assumed Mols. Absorbed	Calc. Mols. Absorbed
C_1	36.83	23	1.60	1.185	.01185	100	1.60	66	66
C_2	28.84	3.1	9.30	8.80	.0880	100	9.30	384	384
C_3	23.58	.95	24.82	28.7	.287	100	24.82	1023	1026
C_4	4.21	.37	11.39	73.2	.736	99.5	11.32	465	469
C_4	4.64	.27	17.20	93	1.01	91.8	15.75	652	652
	.....	.....	.....	.....	.....	.....	.....	2590	2597

$$\text{Mols fat oil necessary} = \frac{652 \times 100}{15.78} = 4130$$

more lean oil than was available while that for 90 percent n-butane showed there were 107 mols of lean oil in excess, so 93 percent n-butane recovery should check very closely. See Table C.

The check of total mols of fat oil of 4130 against 4135 is as close as the curves can be read.

If an intercooler had not been used it would have been necessary to have run heat balances to see if the assumed bottom temperature were correct. In this case a heat balance will give the heat load and number of intercoolers necessary. If the total heat necessary to be removed exceeds what can be removed by a temperature rise of 20°, then sufficient intercoolers must be used so that the temperature rise will never exceed the total rise over the absorber.

End of Part III. Part IV will appear in an early issue.

Adequate Protection NOW of Strategic Oil Supplies Urged

GUSTAV EGLOFF
Universal Oil Products Company, Chicago

OUTLINED here are the worlds' refining situation as well as the strategic oil supplies of the world, which are located in two principal areas: the fields bordering the Gulf of Mexico and the Caribbean Sea; and the fields in the Middle East. The author points out the strategic importance of the prolific sources of oil in the Middle East and their effect on the fueling of a long war, and what it would mean to the countries of the West if this enormous supply should be cut off by Russia or her satellites. "Adequate protection of this are NOW may well slow down or stop the Russian time table for aggression," he declares.

Revisions have been made since this paper was prepared for presentation before the API at Los Angeles.

THE strategic oil supplies of the world are located in two principal areas, viz: the fields bordering the Gulf of Mexico and the Caribbean Sea, and the fields in the Middle East. The total world production of crude oil is about 10,500,000 barrels a day, of which the United States produces about 52 percent, the Middle East 17 percent, Venezuela 14.5 percent, and Russia and her satellites only 8 percent. The combined production of the largest producing areas, viz., the United States, Venezuela, and the Middle East, accounts for almost 85 percent of current world output. Table 1 summarizes the current production of petroleum by world areas.

To compensate for their lack of petroleum supplies, Russia and her satellite countries use the expensive processes of coal hydrogenation and oil-shale retorting to produce additional supplies of oil. It is difficult to determine just how much oil is produced from these processes. In eastern Germany current plans call for the production of 20,000 barrels a day of automotive fuels by the hydrogenation of lignite. In Czechoslovakia a coal-hydrogenation plant is available for producing 30,000 barrels of gasoline a day. It seems reasonable to estimate that at least 100,000 barrels a day of synthetic liquid fuels from coal and oil shale are being produced in Russia and satellite countries. The combined total of crude oil and synthetic oils probably amounts to about one million barrels a day, which is less than 10 percent of total world production.

Table 1

World Crude-Oil Production July, 1950
(Thousands of Barrels Per Day)

Western Hemisphere:			
United States	5,504.0		
Venezuela	1,533.3		
Mexico	195.2		
Other	353.2		
	7,585.7	71.8	percent
Western Europe:			
Germany	21.9		
Netherlands	14.4		
Other	5.1		
	41.4	0.39	percent
Russia and Eastern Europe:			
Russia	730.0		
Roumania	85.0		
Austria	25.0		
Other	23.6		
	863.6	8.15	percent
Middle East:			
Iran	691.2		
Iraq	128.5		
Kuwait	393.7		
Saudi Arabia	558.6		
Egypt	39.9		
Other	96.3		
	1,848.2	17.5	percent
Other Asia:			
Indonesia	130.0		
British Borneo	82.0		
Other	23.1		
	235.1	2.2	percent
World Total	10,574.0		

Most Challenging

Of all the producing areas, the Middle East is by far the most challenging in the world at the present time. It includes the countries of Iraq, Iran, Saudi Arabia, Kuwait, and Bahrein, and has a land area equal to 67 percent of that of the U. S. Control of the Middle East fields is now entirely vested in western democratic nations; 47 percent is held by the British, 41 percent by Americans, 6 percent by the French, and 6 percent by the Dutch. Most of the know-how for exploration and well drilling has been supplied by American and British operators who gained their experience in the oil fields of the United States and other countries in the Western Hemisphere. They have developed this area at great cost and considerable financial risk. Native labor was entirely uneducated for the kinds of jobs necessary to oil production and refining. In addition to this task of training labor, a large number of employes had to be transported from the U. S. and western Europe. Whole new towns had to be built with living quarters, sewage and water systems, schools and recreation facilities to make these areas habitable. Oil companies of the U. S., Britain, France, and Holland have invested superhuman effort in these Middle East fields, and have every right to the oil therefrom.

Middle East oil production is remarkable in many ways. The production per well averages over 5000 barrels a day in all the Middle East fields; and some wells yield as high as 15,000 barrels a day. At present there are only about 300 producing wells. In the U. S., by contrast, there are about 450,000 producing wells averaging about 12 barrels a day, although there are much higher producers in some fields. The average production per well for the whole world is about 20 barrels a day.

Oil production is backed by enormous reserves. The areas of greatest reserves, however, do not always correspond to the areas of largest current production. The greatest development has occurred in the U. S., where almost a million oil wells have been drilled since the beginning of the industry in 1859. Table 2 shows the accumulated

Table 2

Cumulative Crude-Oil Production Through 1949
(Thousands of Barrels)

World	61,737,993
United States	38,939,286
Venezuela	5,000,000
USSR	6,292,471
Total Europe	8,045,208
Middle East	3,371,677

production of petroleum in various world areas since the industry began.

U. S. Commanding Position

The data show that the U. S. has produced 63.7 percent of all the oil which has been brought above the ground. Despite the fact that the higher producing rate in the U. S. would be expected to leave relatively small amounts of oil for the future, the proved reserves have increased throughout the years so that approximately the same ratio of reserves to production has been maintained. Data for 5-year intervals since 1920 are given in Table 3.

Many geologists have estimated the ultimate amount of oil which will be discovered in the world's sedimentary rock formations. With increasing knowledge of earth formations and the types of structures in which oil is most likely to be found, the estimated reserves have steadily increased over the years. Some geologists believe that 1500 billion barrels more of petroleum will eventually be obtained from the earth's oil-bearing rocks. The amount which will be recovered from formations under land areas is estimated to be between 500 billion and 600 billion barrels, approximately 10 times the cumulative world production to date. Reserves of 1000 billion barrels are estimated to be under the continental shelves.

As to the distribution of the oil reserves, the geologists calculate that, of those under the land areas, about 150 billion barrels are yet to be discovered in the Western Hemisphere and p350 billion in the Eastern Hemisphere. The most commonly accepted figure for the U. S. at this time is 100 billion barrels. Table 4 indicates the probable resources.

Of the ultimate resources estimated in Table 4, it appears that about 25 percent are in the Russian zone of domination and 75 percent under the control of the western democratic nations. The estimates are based on known oil-bearing formations. Past experience has shown that oil is also discovered in unpredictable areas, and it is safe to assume that much greater quantities will be found than are predicted at present. Even though they are not, the estimated reserves will supply oil for 500 years at the present rate of consumption. According to these data, there is no foreseeable oil shortage.

Table 3

Estimated Proved Reserves of Crude Oil, Natural-Gas Liquids, and Total Liquid Hydrocarbons in the United States, by Years.
(Thousands of Barrels)

YEAR	Production During Year	Proved Reserves End of Year	Ratio of Reserves to Year's Production
1920	442,929	7,200,000	16.3
1925	763,748	8,500,000	11.1
1930	898,011	13,600,000	15.1
1935	996,596	12,400,000	12.4
1940	1,351,847	19,024,515	14.1
1945	1,736,717	20,826,813	12.0
1949	1,996,669	28,586,000	14.3

Table 4

Land-Area Oil Reserves

Country or Region	Estimated Resources	
	Billions of Barrels	Percent
United States	100	16.7
Venezuela-Colombia-Mexico	45	7.5
Other	65	10.8
Western Hemisphere (Total)	210	35.0
Russia-Siberia	150	25.0
Middle East	150	25.0
Oceania (East Indian Archipelago)	35	5.8
Other	55	9.2
Eastern Hemisphere (Total)	390	65.0
World (Total)	600	100

U. S. Must Protect Strategic Oil Supplies
—So that Power Fuels will be Adequate at All Times.

Refinery Location

In any emergency the location and capacity of refineries are of almost greater importance than production and reserves. Total world refinery capacity is about 11.6 million barrels daily, of which 6.7 million barrels is located in the U. S. Next in capacity are the refineries of Latin America which can process about 1.5 million barrels daily—1,000,000 barrels of which uses Venezuelan crude in refineries at Curacao, Aruba, and in Venezuela. The Middle East has the world's largest refinery at Abadan, Iran, where more than 500,000 barrels of crude oil are charged daily. Other large refineries in the Middle East are the one on Bahrein Island, which charges 150,000 barrels a day, and the one at Ras Tanura, which charges 140,000 barrels. The products of the Middle Eastern refineries are practically all shipped to western European countries because local demands are almost zero.

The refineries in western Europe, which operate mainly on imported crude, are being enlarged under ECA sponsorship, so that by 1952-53 they may be able to supply domestic demands for petroleum products. Table 5 shows refinery capacities in these countries at the end of 1949, and the projected increases in throughput.

Table 5

ECA Recommendations for Increasing European Refining Capacity
(Barrels Per Day)

	End of 1949	1952-53
Austria	7,800*	12,400
Benelux	7,000	165,000
Denmark	600	16,000
France	250,000	375,000
Greece		5,000
Italy	63,000	146,500
Norway	700	700
Portugal	6,000*	9,200
Sweden	11,500	41,000
United Kingdom	135,000	390,000
West Germany	38,000	94,400
	519,600	1,258,300

* 1948.

Table 5 shows that, in the next two or three years, the capacity of western European refineries will be increased by 738,000 barrels per day.

The throughput of Russian refineries at the end of 1949 was 680,000 barrels of crude oil a day. More than 100,000 barrels of oil was charged to refineries in Russian-dominated countries. Including synthetic oils from coal hydrogenation and oil-shale retorting, it seems probable that Russia and her satellites are refining around a million barrels a day of crude petroleum and synthetic oils. Russia is not a highly

industrialized country, and reportedly has 1.25 million motor vehicles of all types—so that production for peacetime transportation is apparently sufficient. In the event of an emergency, however, its oil production and refining facilities would be inadequate.

Refining Picture

The reported refining capacity of a country does not by itself give a complete picture of the amount and quality of its finished products. Crude oils vary widely in composition and hence in their potentialities for making motor and other fuels, and particularly in their suitability for manufacturing quality lubricating oils. The number and quality of finished oils depend not alone on crude oil fractionating capacity but upon secondary processes for conversion and refining of primary products. The quality of products from older refineries is low in comparison with those from more modern plants having up-to-date processes. Also today's refineries are more flexible and can vary the yields of different products as desired. Refineries of the U. S. and many other western democracies are staffed with highly trained and experienced chemists and technicians, and are far better equipped to produce a variety of high quality products than refineries in the Russian bloc. Western refineries are now manufacturing over 2600 different products.

The modern refinery has processes for making gasoline of high-octane rating, since it includes catalytic cracking plants, catalytic reformers for improving octane rating of straight-run gasoline, and polymerization and alkylation plants for utilizing cracked gases to make 100-plus octane rating aviation gasoline. The manufacture of fighting grade aviation fuel is impossible in a refinery lacking alkylation facilities, since 115 to 145 grade aviation gasoline is 75 percent alkylate. It is also current practice in modern refineries to make full use of chemical additives in motor fuel and aviation gasoline, such as inhibitors, metal suppressors and tetraethyl lead to improve quality and stability.

The production of lubricating oils for internal combustion motors is just as important as the supply of fuel and not all refineries are equipped to manufacture high grade engine oils and lubricants for other types of machinery. The techniques employed in making modern lubricants are fully as involved as those used in the manufacture of gasoline. Plants employing solvents for dewaxing, deasphalting and the selective extraction of poor lubricating constituents from lubricating distillates are generally able to make higher yields of higher quality oils than those employing sulfuric acid treating and clay finishing. In the U. S. with its great variety of crude oils, it is widespread practice to segregate particular crudes for lubricating oil manufacture, since some give high yields of good quality products, and others very little. In general, there are more crude oils suitable for lubricant manufacture in the U. S. than in other parts of the world. The manufacture of satisfactory lubricants for today's engines and machines requires not only selected crude oil but complete facilities for vacuum distillation, solvent extraction, and clay treatment. Nearly all of the refined lubricating oils are further improved by special additives which lower pour points, increase viscosity index and oiliness, and prevent oxidation and foaming.

In a wartime emergency, there is stepped-up demand for special lubricants, some for severe service. In the last war, the German offensive bogged down in the Russian winters because the lubricants solidified in automobiles, trucks, armoured tanks and guns. Our own refineries were able to produce superior quality lubricants for every military and civilian use. This is nowhere better illustrated than in the lubricating oils furnished to our airplanes which frequently had to take off from deserts at 160° F. and operate at altitudes where temperatures were 60° F. below zero. U. S. refineries are better euipped for quantity production of high quality lubricating oils than plants in other parts of the world and will be ready to supply any demand.

U. S. World Position

The data given heretofore will be compared to show the distribution of oil supplies in case of a showdown between democratic and totalitarian countries. The democratic nations which have developed the world's oil fields on their own initiative to their present high capacity are in control of about 90 percent of present-day production and about 75 percent of the estimated oil reserves. The U. S. has a production of 5.8 million barrels of petroleum a day at present, with another million barrels shut in but available when needed. It also has access to Canadian and Mexican oil without having to rely on transportation by sea. Nearby are Venezuela and other South American oil-producing nations. We probably can depend on the Venezuela supply in any emergency, although the threat of submarine attack cannot be discounted. It is evident that the United States has more than ample oil for civilian needs and high military demands. However, in a long-scale war, fought thousands of miles away, it would be difficult to supply all requirements if our allies were entirely dependent on us for oil.

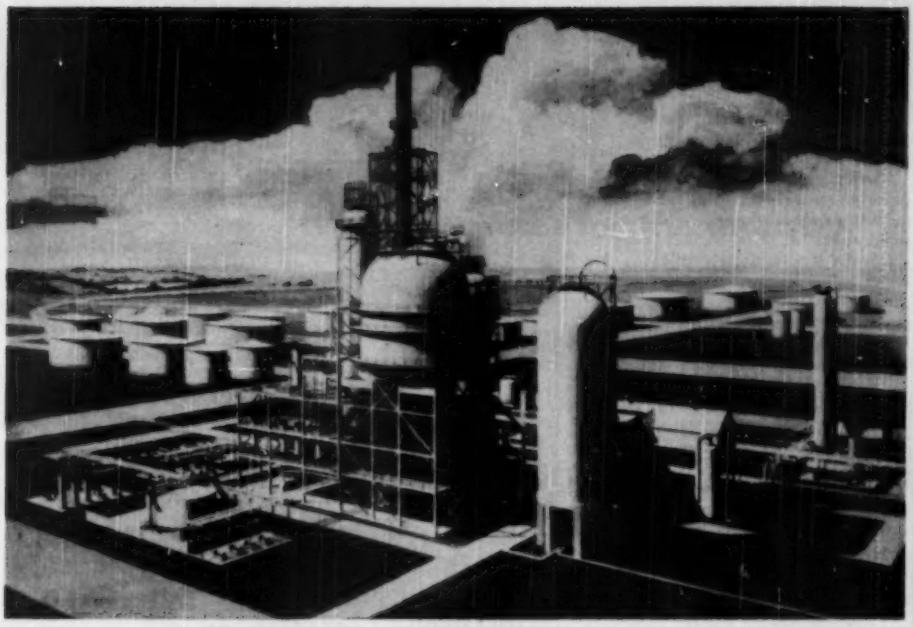
In any long conflict Russia would have to get more oil, and the Middle East stands as the most obvious point to seize because of its proximity. Control would not only divert supplies to Russia and triple her available resources, but also would cut off this source of oil from western European countries, leaving them more prone to invasion. Russia is reported to be fomenting border incidents and tribal wars in Iran with the evident aim of developing a wea kspot which will be ripe for invasion.

Middle East Transportation

The availability of Middle East oil to western Europe in both peace and war is dependent on transportation. Even though control of the Middle East fields remained in friendly hands, western Europe would be cut off from this supply if transportation were disrupted. Heretofore the oil has been carried entirely by tankers for 3650 miles around the Arabian peninsula and through the Suez Canal, but a 1000-mile pipe line has recently been completed which will carry as much as 500,000 barrels per day directly to the Mediterranean. In case of war the pipe line is vulnerable to air attack, but tanker transport is subject to the usual hazards of maritime transportation and the vulnerability of the Suez Canal to air attack. The pipe line is of greatest importance in any emergency because it opens a second route of supply. The pipe line also has the advantages of offering much cheaper and faster transportation.

Another point which should be considered is the vulnerability to attack of the large Middle Eastern refineries and storage tanks: In the event of war every attempt would be made by the opposite side to attack these sources, regardless of who had control over them.

Russia, however, is much less likely to start a war if she does not have this prolific source of oil. By maintaining control in the hands of the democratic countries, the tide may eventually be turned against communistic expansion and peace maintained throughout the world. The western powers must make it clear that they will resist to the limit any effort to wrest control of the Middle East oil from the democratic nations which have developed these resources for the benefit of mankind. Adequate protection of this area *now* may well slow down or stop the Russian time table for aggression.



Above—Artist's conception shows how the fluid catalytic cracking unit of the Anglo-American Oil Company's Fawley (England) refinery will look. The new plant is to be England and Europe's largest. (All photos by Acme.)

Work Progresses on Europe's Largest Oil Refinery

Fawley, England, Plant Will Cost $100 Million

MORE than 5 million tons of petroleum products annually are expected to be produced at Europe's largest oil refinery, under construction at Fawley, Hampshire, 15 miles southeast of Southampton, England. The refinery will cost $100 million.

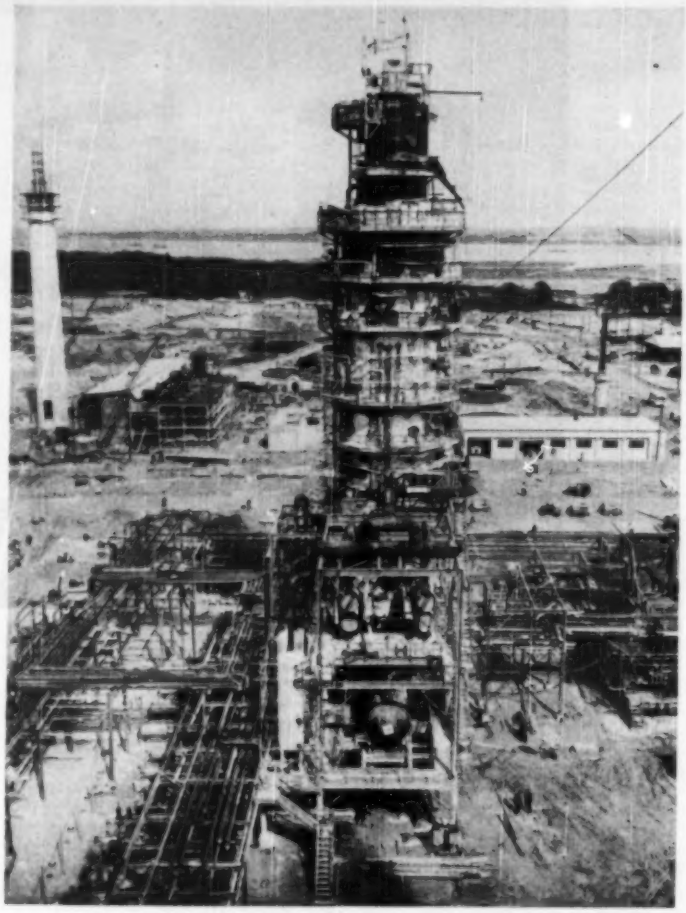
Planned output in barrels per day is crude naphtha and white spirit, 42,500; kerosines, 6000; diesel fuels and gasoils; 14,000; light fuel oils, 6000; bunker fuel, 30,000; and asphalts, 3500.

Under construction by Anglo-American Oil Company, Limited, the refinery will stand as an example of U. S. and British cooperation, for U. S. and British contractors and specialists have worked together, and both U. S. and British capital are involved.

Though it involves no Marshall plan aid, government approval has been given the project which was first announced in November, 1946. Actual work began in June, 1949, and completion is sched-

At left—Everything will be provided for the men who work at England's new oil refinery. Here is the recreation club and entrance to the movie theater which has a seating capacity of 500. New homes are being built in nearby Southampton and other towns.

At right—This is general view which shows part of the huge Southampton refinery site where work is in progress. In the foreground rises the tall fractionating tower. A strip of Southampton water is visible in the background.



uled for the first of 1952.

Fawley was selected as the site because of the existing plant there which permitted progressive and comparatively rapid utilization of the new facilities.

Crowes Roads, approximately 5¼ miles from Fawley, provides a safe, sheltered anchorage. The navigable channel between it and Fawley is 36 feet low water ordinary spring tide and 38 feet low water ordinary neap tide.

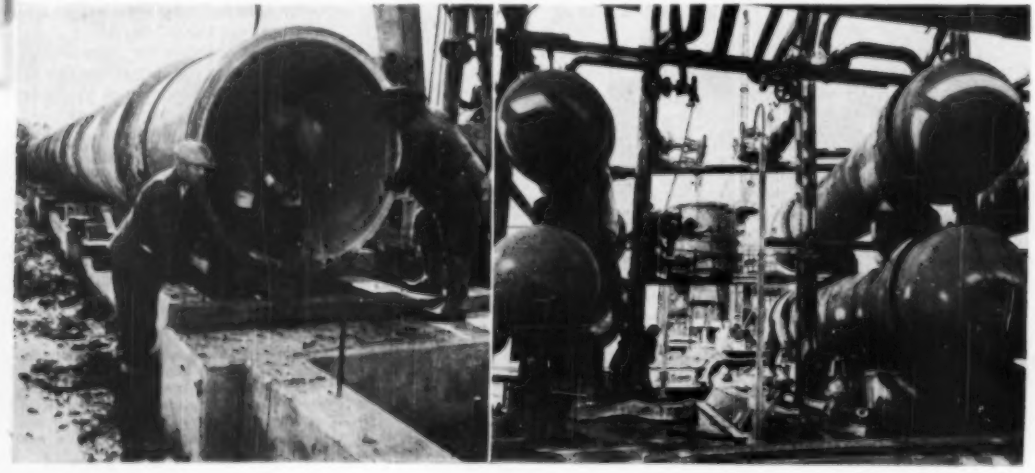
The plant will stand on land that was once lush grazing land bordering salt marshes. A belt of trees will screen the refinery from the remaining forest and field area.

Approximately 2000 people will be employed at the refinery. Facilities for them are already being built in nearby Southampton and other towns further away.

Three main uits will comprise the new refinery. They are a distillation unit of pipe stills of 60,000 barrels per day capacity feeding one atmospheric and one vacuum column; a fluid catalytic cracking unit with an output capacity of 37,000 barrels per day; and an Edeleanu plant for sulphur reduction.

The design of these units has been primarily by Standard Oil Development Company. Foster Wheeler Corporation of the U. S. A. has processed and supervised most of the units, with its affiliate, Foster Wheeler, Ltd., supervising much of the work.

Below, right—A triumph in economics is the complicated network of heat exchangers which take the heat out of outgoing products and transfer it to the cold incoming products. Left—Sixty-five thousand gallons of salt water will flow through this 60-inch effluent pipe every minute after having cooled the plant.



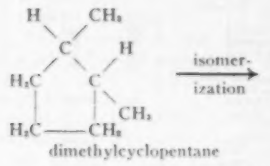
Platforming Natural Gasoline—Its Potentialities for the Industry

W. F. FULTON

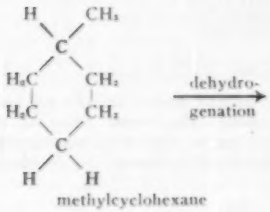
Fairbanks, Texas, Laboratory, Warren Petroleum Corporation

EARLY in 1949 Universal Oil Products Company announced a new process for reforming hydrocarbons boiling in the "straight run" gasoline range (150-450° F.). Called "Platforming" because in the process a platinum catalyst is used in reforming the hydrocarbons, it converts the naphthenes to aromatics, hydro-cracks the normal paraffins, and isomerizes some of the paraffins and naphthenes. At the same time it converts the sulfur compounds if present to hydrocarbons and hydrogen sulfide which is removed. The process is a non-regenerative catalytic process.

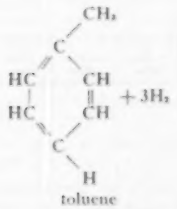
In the conversion of the naphthene hydrocarbons to aromatic, the reaction is the same as in hydroforming. Straight run and natural gasolines usually contain substantial amounts of naphthenes of the five and six membered ring types. In the case of the five member ring compounds the reaction is as follows:



dimethylcyclopentane



methylcyclohexane



toluene

During dehydrogenation a large amount of heat is used up rapidly and three moles of hydrogen are liberated by each mole of naphthene aromatized. This causes a shrinkage in volume because the aromatic formed is more dense.

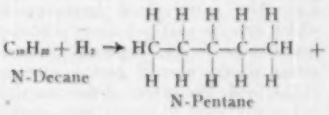
If pure methylcyclohexane were processed the yield of toluene would be about 83.3 percent by volume of the charge, and the octane number would be increased from 74.8 research octane to 124 (blending octane number), or an increase of approximately 50 octane numbers.

NATURAL gasoline plant operators have high economic interest in the application within their plants of conversion processes that will yield high quality motor fuel components. Under certain conditions the Platforming process is well suited to such use in natural gasoline plants, and in still other cases may be specifically adapted to the production of aromatics.

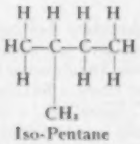
The author, who presented this discussion before the recent Tyler, Texas, regional meeting of the Natural Gasoline Association of America, has studied the application of several processes to gasoline plant needs, and here briefly explains their uses and limitations.

The term hydro-cracking is used to designate a cracking and hydrogenation reaction such as those which cause a decrease in density of the products and also an increase in the *vapor pressure*. This step absorbs some of the hydrogen liberated in the dehydrogenation step. The reaction is exothermic, that is, it liberates heat, but the rate is much slower than the dehydrogenation reaction. Hydro-cracking involves the cracking of the heavier molecules into smaller ones of lower molecular weight.

The reaction here is different from thermal cracking because it does not crack the molecules indiscriminately. It is a three way reaction, cracking-isomerization-hydrogenation, all in one, as:



N-Decane N-Pentane



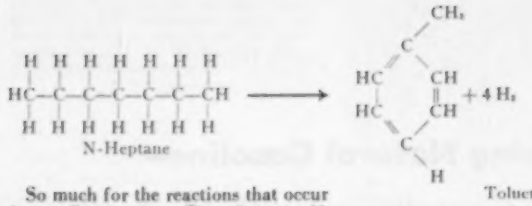
Iso-Pentane

This would be ideal, but during commercial operations, propane, butanes, pentanes, hexanes, and heptanes are all formed at the same time. If all of the decane went to pentanes the volume increase would be 18 percent more products than the original charge. The octane would increase approximately 100 units, but the vapor pressure of the product would go from 0.07 pounds at 100° F. to 18 pounds at 100° F. The isomerization reaction converts the normal paraffins to iso-paraffins and improves the octanes as shown by processing pure n-heptane to produce components shown in Table 1.

Table 1

Component	Percent C_7 Cut Excluding N-C_7	Research Octane
3-methyl hexane	46.2	52.0
2-methyl hexane	30.6	42.4
2,3-dimethyl pentane	10.9	91.1
2,2-dimethyl pentane	4.7	92.8
3,3-dimethyl pentane	4.5	80.8
2,2,3-trimethyl butane	3.1	+1.8 cc lead

Some dehydrocyclization occurs that converts straight chain compounds into aromatics direct, as:



So much for the reactions that occur during Platforming. The plant, itself, consists of a feed heater, three reactors, and fractionating equipment as shown by the flow diagram.

The temperature, pressure, space velocities of feed, and hydrogen recycle have a marked effect on the products produced and the quantities of product made. The approximate conditions and results will be shown by the first commercial unit built in Muskegon, Mich. The unit was constructed in 139 days, and completed in October, 1949.

The feed was prepared by removing the *light ends* of the straight run gasoline. The only octane improvement which can be obtained from *pentanes* and *butanes* is due to partial isomerization of the normal portion present in the feed. The extent of this reaction is not sufficient to justify the processing of *pentanes*.

The hexanes and heptanes boiling range includes the five and six membered cyclo compounds (naphthenes) as well as low octane normal hexane and normal heptane. Therefore, it is advantageous to include material boiling from 150-400° F. in the feed stock. Nothing would be gained by including the material boiling from 110-150° F., the iso-hexanes.

Hydrocarbon feed is pumped to the reactors at 700-750 pounds by plunger pumps, preheated by exchange, and then pumped to the heater where the charge is heated to 890° F. and passed through the reactors (See Figure 1). The product is condensed under full pressure at 100° F., the gas and liquid portions separated, and the recycle gas is taken from the top of the drum (about 60 percent) and recompressed and recycled. This gas is about 85 percent hydrogen. The liquid is fed to a stabilizer to remove remaining hydrogen and low molecular weight hydrocarbons. The product has very low gum and high stability due to low olefin content.

Table 2 shows results of this first commercial unit.

Now apply this process to natural gasoline. First, define natural gasoline as that mixture of hydrocarbons extracted from natural gas and casing head gas by means of an absorption plant. Condensate is that liquid mixture of hydrocarbons that can be separated by mechanical means, such as a separator, trap, or fall-out in pipe lines. This condensate will have a gravity of 50-68° API and consists mainly of hexanes plus (75-90 percent) after weathering to atmospheric pressure. This type of hydrocarbon usually has about 10-15 percent material boiling above 400° F. and ranges in color from water white to dark straw color. This type condensate or mixture of hydrocarbons is identical

Table 2

Operating Data on Commercial Unit
Period—February 6 to 9, 1950

Hours on Catalyst	1901-2057
Pressure on Reactor	720 pounds
Temperature	890° F.

Observed Rates and Yields	Volume Percent of Charge
Feed	100
Stabilized Platformate	92.6
Calculated 10 lb. Platformate	97.1
Outside Butane Required	4.5

Inspection	Reactor Charge	Stabilized Platformate	Calculated 10 Lb. Motor Fuel
Paraffins, percent	62.0	61.0	.....
Olefins, percent	0	1.0	.....
Naphthenes, percent	33.0	1.0	.....
Aromatics, percent	5.0	37.0	.....
Gravity, °API	58.1	57.4	39.7
Vapor Pressure at 100° F.	2.0	6.9	10.0
Sulfur, percent	.08	.0019	.....
Octane Number			
Research Method:			
Clear	52.5	81.3	81.9
Plus 3 cc	70.2	93.9	94.7
Motor Method:			
Clear	48.9	75.5	76.1
Plus 3 cc	68.5	87.4	88.2
ASTM Distillation			
IBP	166° F.	110° F.	.....
10 percent	203	155	.....
50 percent	248	195	.....
90 percent	309	308	.....
EP	355	363	.....
Component Yields			
Cu. Ft./Bbl.			
Hydrogen	.....	401	.....
Methane	.....	80	.....
Ethane	.....	53	.....
Propane	.....	65	.....
Volume Percent			
Iso-Butane	.....	2.1	.....
N-Butane	.....	3.5	.....
Iso-Pentane	.....	5.0	.....
N-Pentane	.....	2.9	.....
Hexanes Plus	.....	80.3	.....
	.....	93.7	.....

Table 3

Butane Free Natural Gasoline Average

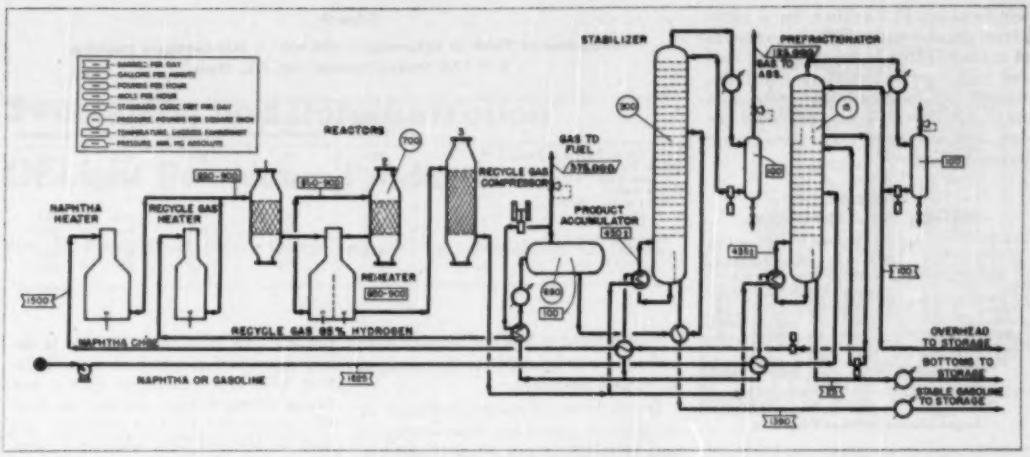
Constituent	Volume Percent	N-Paraffins	Iso-Paraffins	Naphthenes	Aromatics
Iso-Pentane	23.46		23.46		
N-Pentane	21.19	21.19			
Cyclopentane	1.14			1.14	
2,2-Dimethyl Butane					
2,3-Dimethyl Butane	9.62		9.62		
2-Methyl Pentane					
3-Methyl Pentane					
N-Hexane	9.90	9.90			
Methyl Cyclopentane	4.25			4.25	
Benzene	1.09				1.09
2,2-Dimethyl Pentane					
2,4-Dimethyl Pentane	.42		.42		
2,2,3-Trimethyl Butane					
Cyclohexane	2.61			2.61	
2,3-Dimethyl Pentane					
2-Methyl Hexane	3.79		3.79		
3-Methyl Hexane					
1,1-Dimethyl Cyclopentane					
1,3-Dimethyl Cyclopentane	3.36			3.36	
1,2-Dimethyl Cyclopentane					
N-Heptane	2.72	2.72			
Methyl Cyclohexane	2.24			2.24	
Ethyl Cyclopentane	1.27			1.27	
2,2-Dimethyl Hexane					
2,4-Dimethyl Hexane	.54		.54		
2,5-Dimethyl Hexane					
1,2,4-Trimethyl Cyclopentane	.75			.75	
Toluene	.82				.82
2,3-Dimethyl Hexane	.43		.43		
2-Methyl Heptane					
3-Methyl Heptane	1.07		1.07		
4-Methyl Heptane					

Constituent	Volume Percent	N-Paraffins	Iso-Paraffins	Naphthenes	Aromatics
1,3-Dimethyl Cyclohexane					
1,4-Dimethyl Cyclohexane	.67			.67	
1-Methyl-2-Ethyl Cyclopentane					
N-Octane	1.13	1.13			
1,2-Dimethyl cyclohexane					
Propyl cyclopentane	.97			.97	
Iso-Propyl Cyclopentane					
Ethyl Cyclopentane					
Ethyl Benzene	.09				.09
Heavier Aromatics	1.37				1.37
Heavier Paraffins	3.64	3.64			
Heavier Naphthenes	1.12			1.12	
	100.00	38.58	39.67	18.38	3.37

Average boiling above 250° F., 6.13 percent.

Summary

Hexanes	26.00	9.90	9.62	8.00	1.08
Heptanes Plus	29.35	7.49	6.59	10.38	2.28
	55.35	17.39	16.21	18.38	3.37
100 percent Basis, Vol. percent	.....	.....	61.0	33.0	6.0



Flow Diagram of Platforming Continuous Catalytic Reforming Process. Heated recycle gas is combined with heated naphtha feed in the process. Inlet and outlet temperatures of third stage reactor are substantially the same, so effluent is used in reboilers and feed heating.

with "straight run" gasoline made from crude oil and will be treated the same in processing. The composition as to naphthenes, paraffins, and aromatics is the same as that distilled from crude oil of the same type base if produced in the same area. "Condensate" is excluded.

Natural gasoline can be processed by Platforming only after fractionation into its constituents, such as butanes, pentanes, and hexanes plus. Then the only portion of natural gasoline that can be processed successfully by platforming is the hexanes plus, boiling from 150-350° F.

The literature shows that all of the feeds processed were really "condensates" containing 80-88 percent hexanes plus, and in many cases heptanes plus boiling at 250-400° F. having 50 percent boiling above 300° F. Now the average natural gasoline contains from 2 percent to 6 percent boiling above 250° F. and about 3 percent boiling above 300° F.

Table 3 contains an average of many high temperature Pod analyses of natural gasolines.

All percentages are based on butane free natural gasoline.

After platforming the above hexanes plus the product would contain approximately 60 percent iso-paraffins and 40 percent aromatics.

This analysis shows that the average natural gasoline contains 55.35 percent hexanes plus, of which 17.39 percent is normal paraffins, 16.21 percent iso-paraffins, 18.38 percent naphthenes, and 3.37 percent aromatics, all percentages being based on butane free natural gasoline.

Now if we platform the hexanes plus (55 percent) and convert the naphthenes to aromatics and the normal paraffins to iso-paraffins we will have a product containing 60 percent iso-paraffins and 40 percent aromatics. This product will be about 7 pounds vapor pressure at 100° F. and we can add about 4-5 percent n-butane or 10 percent pentane mixture and have a high octane 10 pound motor fuel. This 10 percent pentane would be equivalent to 5 percent on original pentanes and would give 97.5 percent or original volume of gasoline. This leaves an excess of 40 percent pentanes and if the original natural gasoline was 26 pounds containing 30 percent n-butane, this would be in excess too.

To show better the yield from 26 pound natural gasoline, if 100 barrels were processed products as shown in Table 4 would be made, processing only hexanes plus:

Table 4

From 1 Barrel of Hexanes Plus—	Gallons	Volume Percent
Hydrogen, Methane and Ethane (Volume Equivalent)	.863	2.05 454 cu. ft.
Propane	1.783	4.25
Iso-Butane	.882	2.10
N-Butane	1.470	3.50
Iso-Pentane	2.100	5.00
N-Pentane	1.218	2.90
Hexanes Plus	33.684	80.20
	42.000	100.00

This shows a production of 17.75 volume percent of propane, butanes and pentanes from each barrel of hexanes plus processed besides 454 cubic feet of hydrogen, methane and ethane.

On basis on 93.7% yield—
93.7% × 55.35 = 51.86
Add pentanes = 5.00
56.86% of 10 pound motor fuel

Note: This is on a butane free basis.

To convert back to 26-pound gasoline containing 30 percent n-butane would reduce this yield to 39.80 percent of 10-pound motor fuel produced from original 26-pound natural gasoline, or as shown by Table 5 on a basis of 100 barrels of 26-pound natural gasoline.

Table 5

	Starting Feed, Barrels	Products, Barrels
N-Butane	30.0	30.0
Iso-Pentane	16.5	14.6
N-Pentane	14.8	13.1
Hexanes Plus	38.7	39.8
	100.0	97.5

Loss and Gas, 2.5 barrels.
NOTE: Processing only 38.7 barrels of hexanes plus.

Now it is not fair to convert back to 26-pound natural gasoline because you have not processed but 38.7 percent of the 26-pound natural gasoline. You still have the butanes, pentanes (less 5 percent used in the motor fuel), and the 10-pound high octane motor fuel. But you have processed only straight-run gasoline or its equivalent 150-300° F. boiling range. The process does not apply to butanes and pentanes which constitute 61.3 percent of 26-pound natural gasoline.

If you are fortunate and have a large quantity of hexanes plus or condensate at your plant (with no transportation cost), say 1500 barrels per day, or can join in with adjacent plants and accumulate 1500 or 2000 barrels per day of condensate, then you can afford to platform this material very economically.

The cost of such a plant is about $700,000 for a 1500-barrel-per-day

unit to about $1.6 million for a 5000-barrel-per-day unit. This is exclusive of a fractionator to break up the feed and will vary with different utilities, set-ups, and locations. Operating costs are about 32 to 37 cents per barrel per day, and utility requirements are shown in Table 6.

Table 6
Operating Cost of Platforming

	Cost per Barrel per Charge	
Labor	$0.04	to $0.05
Royalties	.07	.07
Catalysis	Less than .10	.10
Maintenance	.03	.05
Taxes and Insurance	.04	.05
Utilities	.04	.05
	$0.32	$0.37

Approximate Utilities Required

Steam, Lbs./Hour	650	to	800
Cooling Water, Gal./Minute	700		900
Electricity (440 Volts, 3-Phase, 60-Cycle:			
Power, kw. hour	205		250
Lights, kw. hour	15		25
	220		275
Air for Instruments, cu. ft./min.	35		45
Fuel Gas for Heaters (1290 B.t.u. per cu. ft.), cu. ft./hour	19,250		25,100

The analysis of the average natural gasoline will show that the composition of the feed to the commercial unit and the hexanes plus of the natural gasoline are the same as to naphthenes (33 percent), paraffins (62 percent), and aromatics (5 percent), and the boiling range would be about the same. Therefore the yields and octanes should be the same.

In conclusion, the Platforming process is an economical process for raising the octane of a mixture of hydrocarbons boiling between 150-400° F., containing sufficient quantities of naphthenes and normal paraffins to be converted to aromatics and iso-compounds.

If there are sufficient naphthenes the product would be valuable for the recovery of the aromatics, such as benzene and toluene.

Table 7
Comparison of Yields in Reforming a 200-400° F. Mid-Continent Naphtha. K = 12.0 Octane Number, 35, F-2, Clear.

	Cracking Thermal	Cracking Polymerization	Polyforming	Hydro-forming	Platforming
Yield, Volume Percent 10 Pound V. P.	86.0	80.0	80.0	84.0	95.0
Outside Butanes, Percent	0	2.0	0	6.0	4.0
Total Yield, Percent	86.0	82.0	80.0	90.0	99.0
Octane Rating:					
Motor Method (F-2)					
Clear	75.0	75.0	75.0	75.0	75.0
Plus 3 cc. tel.	84.0	84.0	85.0	86.0	87.0
Research Method (F-1):					
Clear	85.0	85.0	86.0	81.0	80.0
Plus 3 cc. tel.	93.0	93.0	94.0	93.0	93.0

Platforming is OK for hexanes plus and only can be used on that portion of natural gasolines.

If you have sufficient condensate or straight-run gasolines Platforming is both economical and a low investment cost process. There are other processes such as polyforming, a high-pressure (1500 pounds) cracking and thermal polymerization process. It has certain advantages depending on the type of feed. It also requires a material boiling between 150-450° F. It has no value for butanes and pentanes except at high recycle rates, which makes it uneconomical from an investment and cost of operations standpoint at the present time.

Cycloversion requires the same type of feed as the other processes but is low pressure.

All the processes now available for reforming natural gasoline are successful only on the hexanes plus fraction or its equivalent mixture of hydrocarbons, condensate, straight run, etc.

What the natural gasoline manufacturer needs is a process that will convert the butanes and pentanes into a lower vapor pressure and higher density product. This is the reverse of all present processes which produce a lower density and higher vapor pressure product.

The only method available at the present time to accomplish this is dehydrogenation of n-butane and alkylation with iso-butane to give a low vapor pressure high density product. Of course this type of material can then be blended with additional natural gasoline, but a plant of this type to process 3000 barrels per day of n-butane would cost approximately $17 million.

If the natural gasoline manufacturer can find a method of converting butanes to a motor fuel type hydrocarbon without excessive and uneconomical losses, the problem of production would be solved.

He would still be faced with the major problem of transportation of products both to and from the plant. Shipment by tank car is out of the question for raw materials. The freight alone would amount to 33 percent of cost of feed delivered to the plant. He could not afford to bring in condensate or heavier materials to help blend off butanes and pentanes he has in excess.

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Sweetening and Desulfurization Of Light Petroleum Products

Part II. Analysis of Sulfur Compounds in Light Petroleum Distillates

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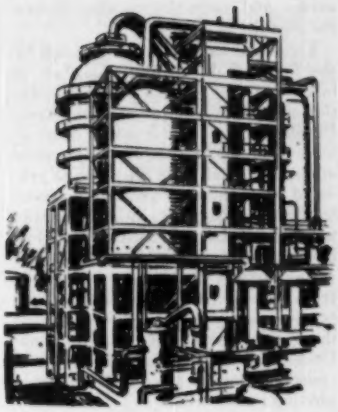


THIS IS the second article of a series that will present a rather complete study of the chemistry and procedures employed by refineries for treating petroleum products from sulfur-bearing crude oils.

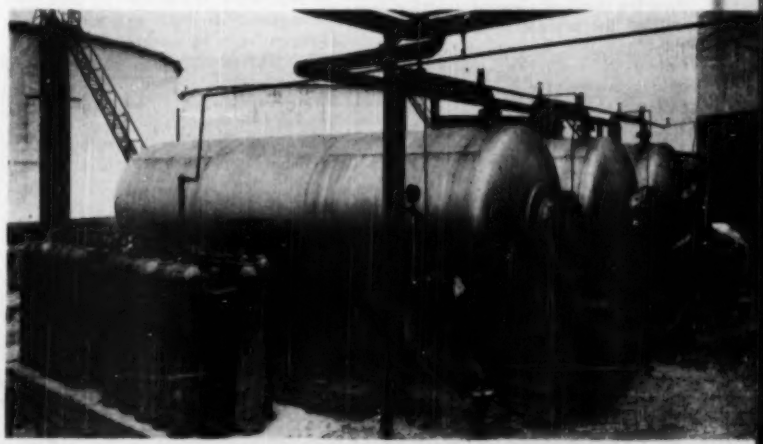
The basic series will deal at length with chemical and process considerations, so that there will not be sufficient space for detailed descriptions of treating plant equipment and mechanical construction. Too, such details would tend to complicate the discussion of chemical matters, and lead to pointless repetition. These physical details, however, deserve attention. They will be described in separate but parallel articles, beginning with Part III of the series, "Sodium Plumbite Treatment."

SULFUR compounds associated with petroleum are of extremely varied characteristics and their identification presents a problem not less complex than that involved in isolation of individual hydrocarbons. This may be easily visualized by inspecting the extensive tables of sulfur derivatives likely to be present in petroleum and which were prepared by Helm, Haines and Ball.[11] Routine laboratory inspections are usually limited to the determination of total sulfur content and, in some instances, to the estimation of the quantities of some of the most reactive groups present. Even this superficial examination requires a considerable amount of laboratory work and a large number of sulfur compounds in the oils remains undetected.

In interpreting the analytical results the fact must be recognized that in many instances the accuracy of the data is affected by the presence of certain types of sulfur compounds not directly involved in the analysis. Changes in composition may also occur because of the interreaction of some of the oil components in storage, particularly under the influence of light and heat or atmospheric oxygen. All these factors must be taken into account in drawing conclusions on the basis of laboratory data and importance of duplicate determinations cannot be underemphasized.

The presence of elemental sulfur may be detected by the copper strip corrosion test[2] provided hydrogen sulfide has been removed by washing the sample with caustic solutions or by some other means. The test is qualitative and is affected not only by hydrogen sulfide but by other sulfur derivatives like mercaptans, polysulfides or sulfuric acid esters. The action of elemental sulfur is sometimes intensified by the presence of these compounds in non-corrosive quantities. For instance, the minimum amount of elemental sulfur that can be detected in the gasoline by using this method is about five parts per million in the absence of mercaptans. Pure ethyl mercaptan is not corrosive in concentrations as high as 2.4 percent when dissolved in benzene or normal heptane. However, when a little of it is present in the gasoline the corrosive concentration of elemental sulfur is reduced to one part per million.[9] The temperature at which the test is made has also a marked effect on the results obtained. Substances may not be corrosive at low temperatures and become highly corrosive when the temperature is raised. At sufficiently high temperature levels all gasolines may be shown to be corrosive.

Another test proposed for detecting elemental sulfur consists in shaking gasoline with mercury at room temperature. The test is capable of showing the presence of elemental sulfur in quantities less than one part in ten millions[10] which makes it too sensitive for use in plant control. Organic per-



oxides and polysulfides also darken the surface of mercury.[13]

Elemental sulfur may be detected by the inverted doctor test. Gasoline is mixed with the sodium plumbite solution and with a solution of mercaptans. Development of black color immediately after shaking shows the presence of elemental sulfur in the gasoline provided hydrogen sulfide was removed by first washing the gasoline sample with a solution of caustic. Any low boiling mercaptan might be employed for this test by dissolving it in naphtha from which all the objectionable compounds were removed. Sensitivity of the test can be adjusted within certain limits by varying the quantities and concentrations of the reagents. By employing equal volumes of gasoline under inspection and sodium plumbite solution and adding to this mixture ten percent by volume of a one percent solution of ethyl mercaptan in naphtha the presence of two and a half parts of elemental sulfur per million parts of gasoline can be discovered[26] thus making the test twice as sensitive as the copper strip test. Similarly by mixing equal volumes of gasoline under inspection, sodium plumbite solution and a solution of normal-butyl mercaptan (one part of mercaptan per 1400 c.c. of naphtha) a positive test is obtained with sulfur concentrations in the gasoline of twenty parts or slightly less per million.[19] Under some conditions the color of lead mercaptides formed may interfere with the accuracy of the results obtained but this can be avoided by employing pyridine instead of naphtha in preparing the mercaptan solution.

Still another test developed for the same purpose involves mixing 5 c.c. of gasoline under inspection with 3 c.c. of pyridine followed by shaking with 0.5 c.c. of 2N sodium hydroxide solution.[21] If the gasoline contains more than ten parts of elemental sulfur per million the middle phase acquires a sky-blue color. The color may disappear on prolonged shaking because of oxidation of elemental sulfur to thiosulfate.[19]

Most of the tests of the above nature can be made semi-quantitative by comparing the observed color intensities with those secured with sulfur solutions of known concentrations or by diluting the sample with sulfur free naphtha until the lowest limit of sensitivity is obtained.

The presence of mercaptans is detected by doctor test. The test consists in shaking the gasoline under inspection with the sodium plumbite solution in the presence of flowers of sulfur. The test is capable of discovering the presence of about ten parts of mercaptan sulfur per million parts of gasoline. Its sensitivity varies depending on the experimental procedure employed and the test must be standardized for accurate results.[6] Individual mercaptans also show considerable variation in their response to the doctor test.[12]

Mercaptans may be detected by shaking 5 c.c. of gasoline sample with one c.c. of freshly prepared solution containing one percent of sodium nitroprusside, and with 2 c.c. of a 2 normal sodium hydroxide solution.[18] Development of a purple color indicates the presence of mercaptans. The test is claimed to be particularly useful for detecting mercaptans in kerosine and cresylic acid.

The usual quantitative methods consist in titrating mercaptains with silver nitrate or ammoniacal copper sulfate solutions. If silver nitrate is employed the end point can be determined either by adding to the gasoline an excess of standard silver nitrate solution and titrating back with the standard ammonium thiocyanate solution using ferric alum as indicator[5] or by titrating directly in a solution of isopropyl alcohol and sodium acetate with the standard silver nitrate solution employing a potentiometer.[24] The second method has the advantage of being applicable to colored distillates. A slight modification of the first procedure involving the use of methyl alcohol has been suggested.[16] Its use has been extended to the dyed and inhibited gasolines by substituting sulfuric for the nitric acid. This permits titrating with alkalies the acid which is liberated by the reaction of the silver salt with the mercaptans.[17] In either case removal of nitrogen bases by washing the sample with a 200 percent sulfuric acid solution and water is required.[17] Direct titration with silver nitrate solution is possible by using sodium nitroprusside as an internal indicator in the presence of sodium cresylate and pyridine.[20]

In potentiometric titrations two end points may be observed if elemental sulfur is present in the amount smaller than that of mercaptan sulfur. This is overcome by adding to the gasoline a known quantity of propyl mercaptan before titration.[7] However, elemental sulfur does not interfere with the determination of mercaptans if the colorimetric method is used. No attempt should be made for removing elemental sulfur by shaking with metallic mercury prior to titration because of the absorption of some of the mercaptans by mercuric sulfide formed by the interreaction of mercury with elemental sulfur which may lead to erroneous results.

Direct titration of mercaptans with an ammoniacal solution of cupric sulfate[4] is, probably, the most widely used method because of its simplicity. The use of indicators is also avoided.

Determination of mercaptans in spent or partially spent caustic solutions encountered in the refinery practice is done by acidifying the solutions with acids capable of displacing the mercaptans in the presence of naphtha which dissolves the liberated mercaptans. Naphtha containing mercaptans is then titrated by using one of the afore-mentioned procedures.[15]

Analysis of a petroleum distillate for different types of sulfur compounds necessitates establishing a sequence of testing procedures in order to avoid the undesirable interferences. Several methods were recommended for this purpose as shown below.

One of the methods[27] removes hydrogen sulfide with acid lead acetate and then divides the sample into two portions. One portion is shaken with the sodium plumbite solution and a small volume of one percent naphtha solution of ethyl mercaptan to precipitate lead mercaptides and lead sulfide. The lead mercaptides are dissolved in dilute acetic acid leaving undissolved the lead sulfide which is a measure of the free sulfur present in the oil. The second portion of the sample freed from hydrogen sulfide is handled in a similar manner with the exception that a solution of elemental sulfur is employed instead of the ethyl mercaptan solution. The lead sulfide which is precipitated serves now as a measure of the mercaptan content of the oil.

Faragher[10] precipitates hydrogen sulfide as cadmium sulfide using cadmium chloride solution and hydrochloric acid. Elemental sulfur is next removed with metallic mercury and mercaptans as lead mercaptides with the alcoholic sodium plumbite solution. As an alternate method removal of mercaptans may be accomplished with a suspension of basic lead acetate and by filtering out the precipitated lead sulfide. Disulfides are determined after they are reduced to mercaptans with nascent hydrogen obtained by employing zinc and a dilute hydrochloric or sulfuric acid solution. Sulfides are separated with mercurous nitrate. Total sulfur content of the oil is determined by the lamp method[1] before and after each operation which serves as a measure of the quantities of sulfur present in its various forms.

Ball[3] removes hydrogen sulfide with cadmium chloride solution. Mercaptans are determined by titrating the oil before and after removing the hydrogen sulfide. Elemental sulfur is estimated using sodium plumbite and a naphtha solution of butyl mercaptan. Disulfides are found by reducing them to mercaptans and then titrating with silver nitrate solution. Aliphatic sulfides are removed with mercuric nitrate and their quantity calculated as the difference in the total sulfur content of the oil before and after this operation. Aromatic sulfides and thiophenes are separated with mercurous nitrate and their quantities estimated in a similar manner. In handling mercuric nitrate care should be exercised to avoid explosions because of the violent nature of the reaction.[21]

Several additional procedures for estimating various classes of sulfur compounds present in the oil were suggested.[25] The gasoline sample may be shaken with a 10 percent sodium bicarbonate solution to remove hydrogen sulfide the quantity of which is found by the difference in the total sulfur content of the gasoline before and after this operation.[6] Elemental sulfur is separated from the sample freed of hydrogen sulfide by refluxing it for ten minutes at 70° C. (158° F.) with an equal volume of a 3 percent sodium sulfide solution. Difference in the total sulfur content of the oil before and after refluxing again serves as a measure of the elemental sulfur content. The oil which is now free of oxygen sulfide and elemental sulfur is treated with 5 percent of cadmium acetate to remove the mercaptans and then with powdered mercuric nitrate to eliminate the alkyl sulfides. The resulting product is contacted for four hours at 60° C. (140° F.) with a 30-fold excess of 20 percent sodium sulfide solution in 80 percent ethyl alcohol to determine the disulfides.

Problems are often encountered in the refinery practice which require determination of various types of sulfur compounds found in the spent or regenerated caustic solutions. They are usually analyzed for sulfides, thiosulfates and sulfites.[14] Mixture of zinc acetate and sodium carbonate may be used to precipitate sulfides as zinc sulfide. Sulfides can be titrated iodometrically both in the presence and absence of formaldehyde and the sulfate content estimated by difference. If mercaptans are present the original solution may be treated with zinc acetate, sodium acetate and acetic acid to precipitate sulfides as zinc sulfides which serves as the measure of the quantity of sulfides in the solution. Mercaptans can be removed from the filtrate by extracting it three times with petroleum either while the thiosulfates and sulfites may be determined in the aqueous layer using the standard analytical procedures.

As it was mentioned earlier none of the proposed methods is completely reliable if the oil sample contains many types of sulfur compounds because of analytical interferences. Difficulties are apt to arise with the aromatic sulfur compounds or with the compounds in which the reactivity of the sulfur atom is subordinated to that of a long hydrocarbon chain or to that of other radicals.[2] These substances may possess properties which make them behave not as sulfur compounds but as some other derivatives. Aromatic mercaptans are readily oxidized and tend to polymerize. Thiophene or tetrahydrothiophene appear to react to a certain extent with most of the suggested reagents.[22] An error can be also introduced in determining the total sulfur content of the oil on which most of the analysis depend and which is often considerable because of the limitations involved. For these reasons reproducibility of the results obtained in analyzing oils for sulfur compounds becomes of particular importance and the conclusions should be based more on the relative than on the absolute quantities of the compounds present.

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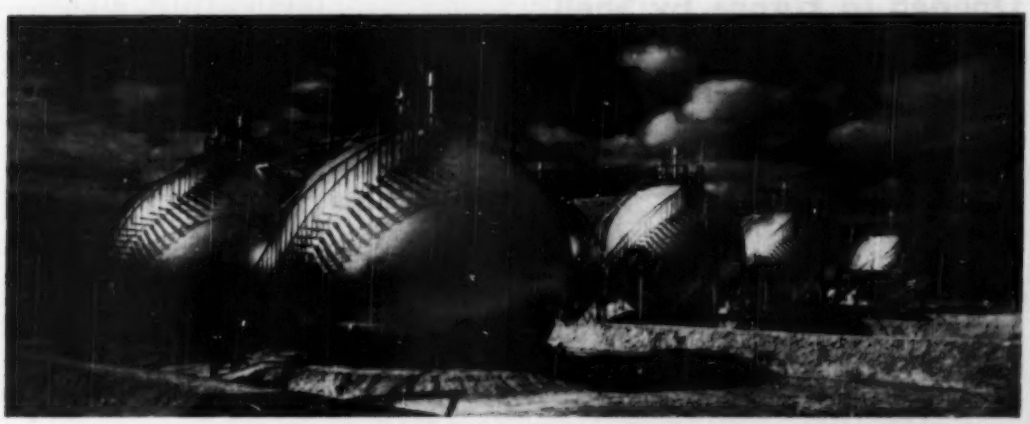
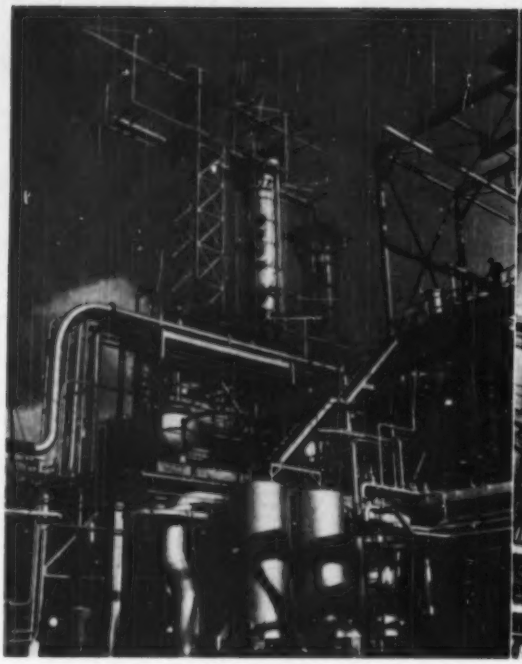
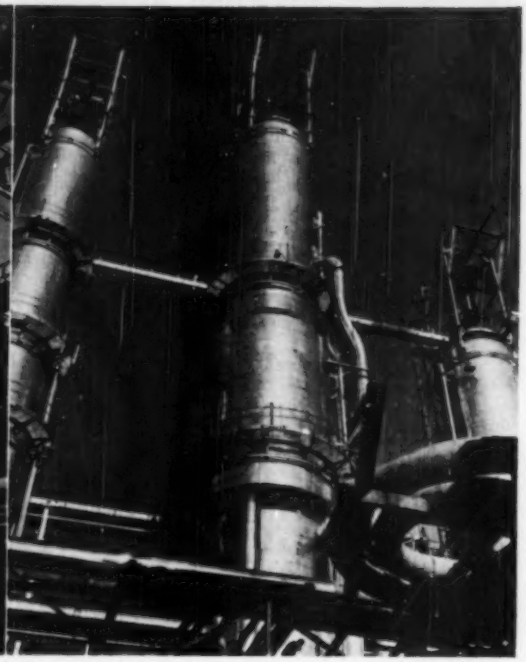




Columns C.4 and C.5 of the distillation plant.



Vacuum columns C.2 (center), C.1 (right), and C.3 (left).

Second Large Postwar Refinery Opened in Europe by Shell

SIX weeks ahead of schedule, the new plant at Shell Oil Company's Shell Haven, Essex, England, refinery has begun operations and is already manufacturing gasoline and other oil products at a rate of 30,000 barrels per day. Production is at the moment confined to one distillation unit and ancillary facilities. The full refinery, scheduled for completion by 1952, will have an output capacity of more than 40,000 barrels. More than 3000 men are employed on the site, a proportion of whom are living in a former prisoner-of-war camp purchased and completely renovated by Shell for labor accommodation.

Associated with this important development in the United Kingdom refinery program is the visit to the Thames Estuary of the 28,000-ton "Velutina," largest British-built tanker in service. Completing a voyage of 6500 miles from the Middle East, this vessel brought to Shell Haven the first cargo of crude oil to be processed at the new plant.

This new refinery is the second of Shell's two new postwar refineries in the U. K. to go on stream. The Stanlow refinery in Cheshire is already producing at a rate of more than 20,000 barrels per day .When the two projects are completed by 1952, Shell's refinery capacity in this country will (with the addition of the 30,000 barrels per day installation at Heysham, Lancastershire) total over 130,000 barrels per day, the largest output of any refinery operator in the U. K.

The reforming unit at Shell Haven, now under construction, is expected to be ready for operation by May of next year. This will process about 10,000 barrels a day of light naphtha or heavy naphtha. After completion of this unit the feed preparation plant will be installed with a maximum capacity of 16,000 barrels per day for the production of bitumen stock to be treated at the existing refinery at Shell Haven.

The final cost of the first stages of the Shell Haven refinery is expected to be $26.6 million. The plant is part of the refinery expansion scheme to increase British refinery capacity from about 50,000 barrels per day as it was in 1947 to over 400,000 by 1953.

Efficiency Characteristics Of Commercial Absorbers

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THE Straight-Line Absorption Chart used in this analysis, described in detail[1,2] previously, consists of an experimentally developed "Percent Absorbed vs. Absorption Factor" grid of such a character that a series of "component recovery vs. absorption factor" points will plot as a straight line for:

1) Any given component (such as propane or isobutane) for most commercial absorbers operating with properly stripped oil at a given pressure on recoveries below 65-70 percent.

2) Any given component for a given absorber operating at a given pressure and given extraction efficiency on recoveries above 80-85 percent.

In addition to the main grid, the chart has superimposed upon it in the lower left-hand corner an operating pressure scale—which scale serves to define the location of the common focal points associated with the straight 85 percent + recovery "operating lines" of the main chart. Lastly, there is drawn across this pressure grid a "percent recovery" reference line whereby percent recoveries vs. absorption factors may be conveniently plotted within the pressure grid area.

The particular absorption factor used with the Straight-Line Chart consists of a simplified form of the Edmeister[3] absorption equation, and employs only data readily obtainable from almost any commercial column operation, namely:

1) Analysis of both the rich and lean gas.

2) Quantity of either the rich or lean gas.

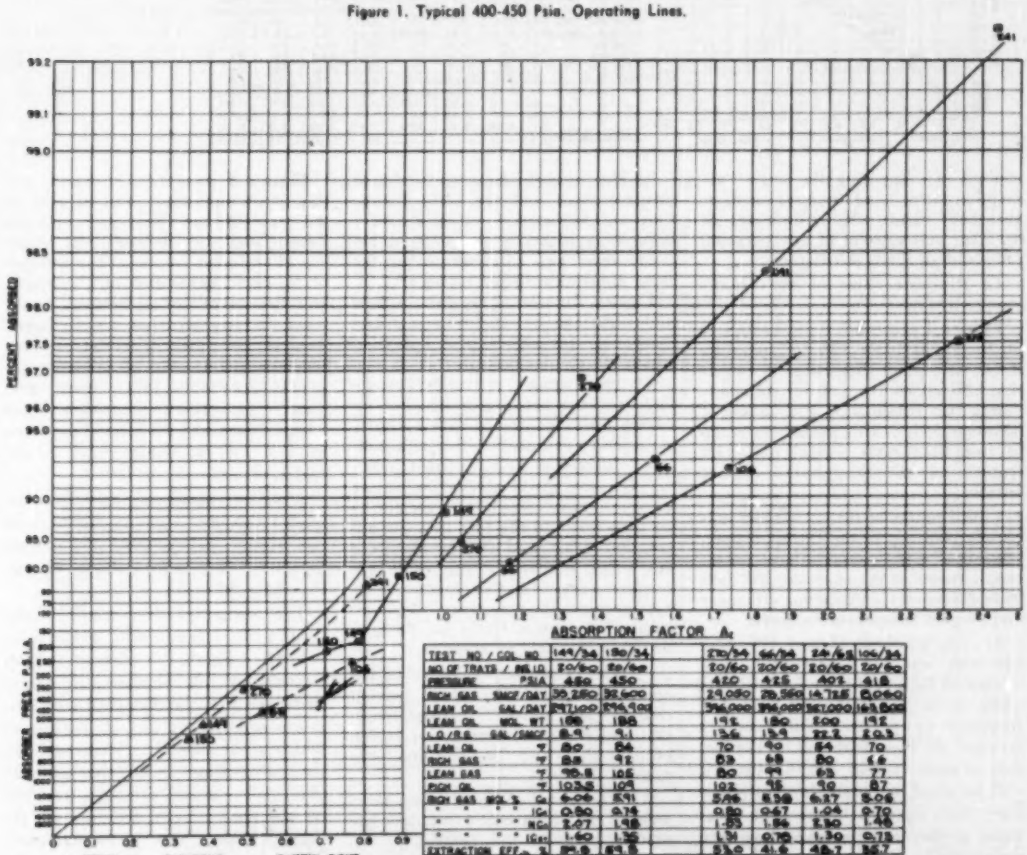
3) Quantity, Engler, and gravity of the lean oil.

4) Column pressure.

5) Rich oil temperature.

In connection with these data, there has also been developed a standardized

Figure 1. Typical 400-450 Psia. Operating Lines.



TEST NO / COL NO	149/34	150/34		230/34	66/34	24/65	106/34
NO OF TRAYS / ABS LD	20/60	20/60		20/60	20/60	20/60	20/60
PRESSURE P.S.I.A.	450	450		420	425	403	418
RICH GAS MCF/DAY	30,280	32,600		29,090	28,560	14,785	8,060
LEAN OIL GAL/DAY	297,100	295,100		396,000	396,000	367,000	169,800
LEAN OIL MOL. WT.	188	188		195	180	200	192
L.O./R.G. GAL/MCF	8.9	9.1		13.6	13.9	22.2	20.3
LEAN OIL °F	80	84		70	90	84	70
RICH GAS °F	88	92		88	68	80	66
LEAN GAS °F	90.8	105		80	99	83	77
RICH OIL °F	103.5	109		102	95	90	87
RICH GAS MOL % C_4	6.06	5.91		5.96	5.58	6.37	5.06
" " " iC_5	0.80	0.74		0.80	0.67	1.04	0.70
" " " nC_5	2.07	1.98		1.93	1.96	2.80	1.48
" " " iC_5	1.60	1.36		1.34	0.70	1.30	0.73
EXTRACTION EFF. %	89.9	89.8		83.0	41.6	48.7	38.7

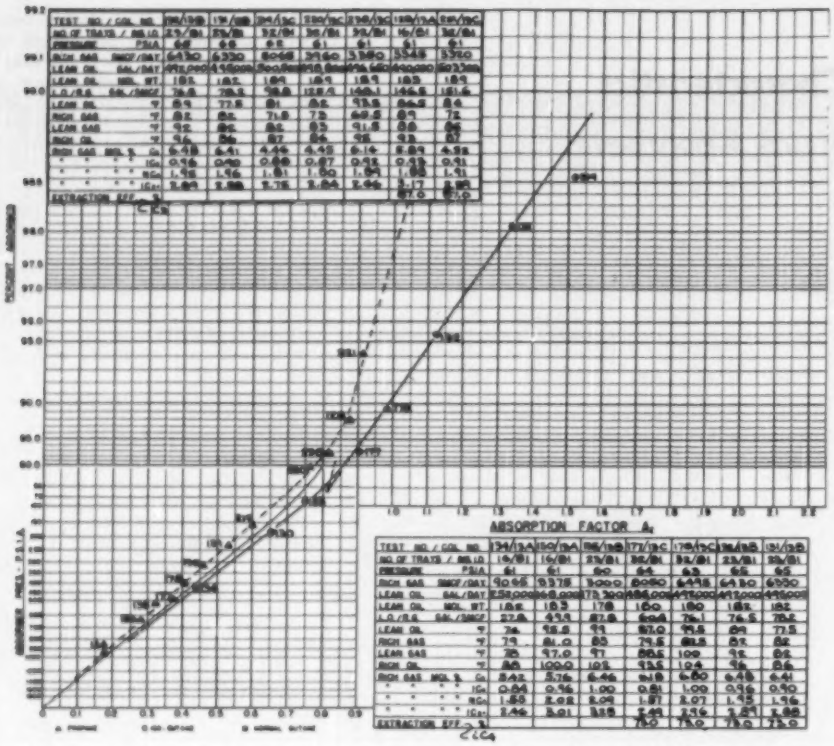


Figure 2. Typical 60-65 Psia. Propane and Butane Traverses."

method of computing the chart "absorption factor" and "percent products absorbed" values which eliminates all need for employment of any personal judgment in their calculation.

To illustrate some of the Chart's unique features:

Figure 1 presents a typical example of Straight-Line Chart "operating lines" covering a wide range of extraction efficiencies for a given column—noting that columns 34 and 65 are of identical design. This particular group of lines illustrates several important features of the Straight-Line Chart, namely:

1) All points of the six subject tests clearly conform to the "straight operating line" and "common focal point" requirements of the chart despite their wide differences in extraction efficiency and percent component recovery.

2) Test numbers 66 and 106 were run with lean oil inadvertently contaminated by a bad interchanger leak, while tests 149-150, 270, and 241 represent operations with properly stripped oil. Despite the oil contamination of tests 66 and 106, however, it will be noted that their resultant operating lines conform to the same focal point as the lines for the properly stripped oil.

3) The "spreads" between the dotted propane lines and the solid butane lines are characteristic of the recovery differences normally encountered between these two components for the same absorption factor values.

Figure 2 presents typical propane and isobutane Straight-Line Chart "traverses" for a 60-65 psia. operation which clearly demonstrate:

1) The "spread" normally encountered between propane and butane recovery lines. We do not have a wholly satisfactory explanation for such indicated differences in component recovery for any given absorption factor value—but are certain they are due in part, at least, to the fact that the absorption factor used with the chart (or any other practically applicable absorption factor for that matter) does not represent the true mean integrated column absorption factor for the particular component in question.

2) The "straight" character of the operating lines below 65-70 percent recovery and above 85 percent recovery, and the curved transition region between these two "straight-line" sections of the chart.

3) The common focal-point character of the propane and isobutane operating lines for 85 percent + recoveries.

Figure 3 presents a blown-up section of the operating pressure grid of the Straight-Line Chart on which we have plotted well defined focal points for 21 different columns. The number of columns represented on this chart, and their excellent agreement, would make it appear that the indicated straight line quite accurately defines the focal-point locus of all normally operating columns, i.e., columns operating with normally encountered gas compositions and with both the lean-oil and rich-gas temperatures in the region of atmospheric.

It will be noted that this latest defined focal-point locus is shifted from our earlier defined line to indicate higher efficiencies for columns operating-above 500 psia.

The reason for the shifting of the focal point location with pressure as defined in Figure 3 is directly tied up with the fact that the absorption factor employed with the Straight-Line Chart is a pseudo factor, the relationship of which to the true mean integrated column absorption factor changes with changes in column pressure—and one of the important features of the Straight-Line Chart is its automatic compensation for such changes by

this noted shifting of the operating-line focal point with pressure.

So much for the unique mechanical characteristics of the Straight-Line Chart—now for some of the important absorber efficiency and operating relationships developed thereby.

Probably the most important efficiency relationship developed by the subject study is the irrevocable proof that *absorption columns can be operated at efficiencies far exceeding those normally encountered in commercial installations.*

Figure 4 presents operating data and associated recovery points for 15 tests on 9 different columns ranging in pressure from 61 to 2100 psia. which are characteristic of super high-efficiency column operation. Referring to the data schedules of this figure, it will be seen that of these 9 columns:

1 was equipped with 32 trays
2 were equipped with 30 trays
1 was equipped with 28 trays
2 were equipped with 24 trays
2 were equipped with 20 trays
1 was equipped with 16 trays.

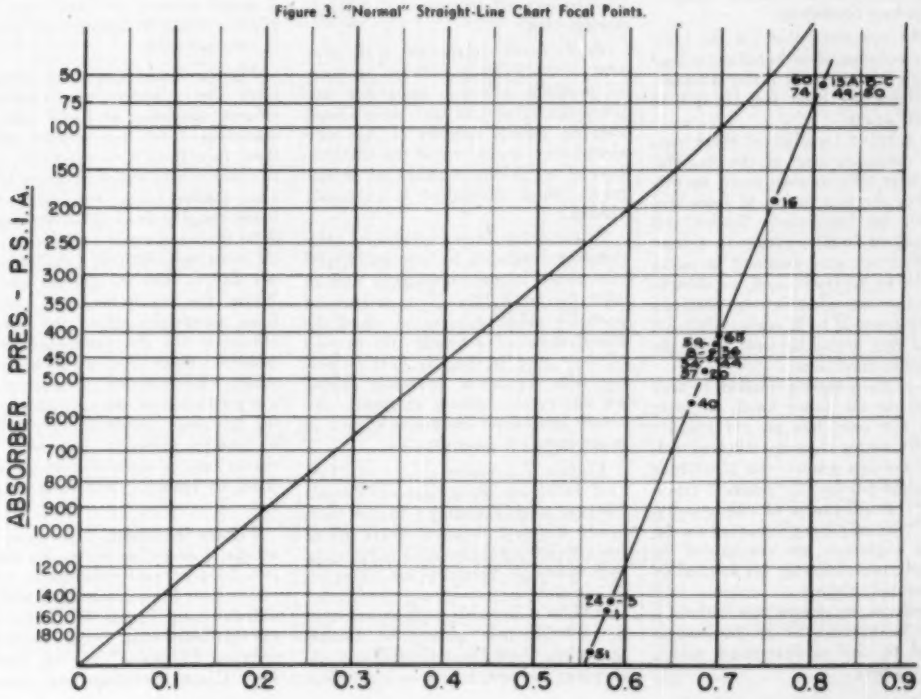
To further dramatize the significance of these tray numbers, we have also drawn on Figure 4 chart a recovery line representing a perfect 32 tray operation—which line lies on or to the right of *every 80 percent + recovery point* on the chart. In other words, on the basis of the conventional "tray efficiency" concept, these nine columns were all operating between 100 percent and well over 200 percent efficiency.

IT HAS BEEN the author's privilege during the last several years to critically analyze some 275 tests on 75 different absorbers ranging in operating pressure from 45 to 2100 psig. Part of these data were incidentally acquired in connection with routine plant surveys, while the balance were the result of carefully run tests on individual absorption units. As would be expected, a considerable number of the incidentally acquired tests have had to be discarded due to obvious inconsistencies in recorded operating data, or to inaccurate samples or analysis thereof. On the other hand, practically all of the special run tests have been found usable. As a result, he has been able to segregate a group of some 200 column tests which fully meet the consistency requirements of the Straight-Line Chart Analysis used in their study. This paper, first presented before the recent 25th anniversary meeting of the California Natural Gasoline Association, gives some of the more important absorber efficiency and operating relationships revealed by this group of test data.

Obviously, of course, no tray can be over 100 percent efficient. The explanation for the apparent 100 percent + efficiencies of the Figure 4 columns again lies in the fact that the absorption factor employed is not a true integrated mean column factor. When we recognize, however, that a great many columns are designed on the basis of a 50-60 percent tray efficiency using absorption factors of this same general derivation, and that most commercial columns are operated at efficiency values markedly lower than those of Figure 4, the high efficiencies revealed in these 15 tests should give real food for thought.

Figure 5 presents an excellent example of the potential savings associated with a really high-efficiency column operation. On this figure we have plotted a series of recovery points for four intercooled columns operated at high propane recoveries. Four of these points (representing the operation of two different columns) define an exceptionally high-efficiency column operation; one, an operation which would be generally accepted as excellent; and one, an operation which would be gen-

Figure 3. "Normal" Straight-Line Chart Focal Points.



erally accepted as good. Yet the generally accepted "excellent" operation required 20 percent more oil, and the "good" operation some 50 percent more oil, to achieve their respective propane recoveries than would have been required to effect the same recovery with either of the noted maximum-efficiency columns. When it is recognized that in this particular case the least efficient column regularly employed some 650,000 gallons per day of oil for its operation, the potential savings associated with substitution in the original plant design of a column having the efficiency exhibited by either of the first two units becomes readily apparent.

The next most important relationship which this study has developed regarding commercial absorber efficiencies is that to obtain the highest over-all column efficiency, *one must utilize trays of individually high efficiency, i.e., one cannot substitute numbers of trays for less efficient individual trays and hope to obtain maximum over-all column efficiencies thereby.*

Figure 6 presents an excellent demonstration of this fundamental relationship. On this figure we have plotted:

1) Operating lines for three columns containing respectively 16, 23 and 32 trays of identical mechanical design, and operating under closely comparable loading conditions.

2) An operating line for the same 16 tray column when handling a load to which it was much better adapted.

3) Operating lines for 16 and 32 "perfect" trays.

The relative location of these particular operating lines on the Straight-Line Chart tells its own story, to wit:

1) For the first group of lines representing an improperly loaded column, only a small increase in extraction efficiency was obtained in going from 16 to 23 trays, and no demonstrable increase whatever was obtained in going from 23 to 32 trays; while all lines of this group lie well under the 16 "perfect tray" line.

2) For the properly loaded 16 tray column, on the other hand, we note that it not only has an efficiency markedly better than the 32 tray column of the first group—but also better than called for by 32 "perfect" trays.

While employment of the conventional "tray efficiency" concept by designing engineers has constituted an extremely useful device for estimating conventional absorption column tray requirements, its general use without a full understanding of its limitations has led to two widespread design errors, namely:

1) Too little attention has been paid to refinement of the individual tray efficiency in light of the conventional thought that "a few more trays would make up for any deficiency in the individual tray design."

2) Forgetting that any normally arrived at absorption factor is a "pseudo factor" at best, designers have been satisfied to obtain "apparent" tray efficiencies of the order of 50 to 75 percent when using such factors, and have largely ignored the presence of isolated column operations such as tests 129-130 of Figure 6 which indicate "pseudo efficiencies" in excess of 200 percent.

Now one can further verify this indictment of the conventional tray efficiency concept by noting that:

1) If the conventional concept of equivalency between numbers of partially effective trays and one theoretically perfect tray were sound, then for three 33⅓ percent efficient trays the vapors leaving the upper tray of any three-tray group would be in equilibrium with the liquid leaving the lower tray of such a group, and the temperatures of the associated vapors and liquid would be the same. Such, of course, is obviously not the case, and the differences existing between the temperatures and equilibrium compositions of such vapor and liquid streams constitute the reason why several partially effective trays cannot be operated together to equal the absorption (or distillation) effectiveness of a single perfect tray.

2) To further elaborate, if the concept of equivalency between numbers of partially effective trays and one theoretically perfect tray were sound, then an infinite number of zero efficiency trays would equal the effectiveness of an infinite number of perfect trays—which conclusion is obviously absurd.

A third important efficiency relationship developed by our study, and one which unquestionably is tied in with the inability of a number of partially effective trays to equal the effectiveness of a single 100 percent efficient tray, is that *the high isopentane-plus recoveries generally quoted for absorption column operations are rarely achieved in practice, and in many cases are unachievable.*

Figure 7 presents a plot of "Percent Isobutane Recovery vs. Percent Pentane plus Recovery" for 40 tests on 20 different columns operating in the 400-500 psia. range. This group of tests meets all Straight-Line Chart requirements for consistency, and hence should be thoroughly representative of the 400-500 psia. absorption column operation. Now theoretically, any absorption column operation in which the isobutane recovery exceeds 50 percent should produce pentane-plus recoveries in excess of 99 percent. As shown by the chart, however, such high recoveries were not obtained in actual practice even with isobutane recoveries as high as 98 percent.

This relationship has been regularly observed by everyone familiar with absorption column testing — but has usually been "shrugged off" as representing an incorrect sample, or an inadvertent employment of poor quality oil at the time of running the test—since everyone knew that "obviously" these recoveries should be, and hence normally were, in excess of at least 98½ percent. We are firmly convinced, however, that the "obvious" is not correct in this case, and that failure to achieve expected high recoveries of isopentane-plus fractions is in many cases due not to improper oil quality, but to the fundamental relationship discussed above regarding inability of imperfect trays to achieve the results obtainable with perfect trays, irrespective of how many of the former trays are employed in the column operation.

In addition to constituting an excellent tool for accurately evaluating the operating efficiency of an existing absorber, the Straight-Line Chart method of analysis can be utilized to accurately predict the operating effectiveness of a given absorber design over a wide range of operating conditions, given a small amount of "key" test data. Figures 8 and 9 demonstrate how this is accomplished.

Figure 8 presents four operating lines for a 16-tray perforated-plate column operating at 61-63 psia. The operating conditions represented by these four lines were carefully chosen to cover a wide range of potential column loading; i.e., employing vapor loads ranging from 3375 thousand to 9650 thousand cubic feet per day, and oil loads ranging from 168,000 gallons per day to 496,000 gallons per day. While the resultant four operating lines accurately reflect the column's efficiency for the particular tests in question, these lines, as such, are not readily interpolated or extrapolated for prediction of the column's operating efficiency under other conditions of loading. However, data from these curves can be cross-plotted on a new chart to readily yield such information.

Figure 9 presents a group of characteristic operating curves for the subject 16 tray perforated-plate column which have been constructed with data derived from Figure 8. The ordinate for this latter chart is the "Butane Extraction Efficiency" of the Straight-Line Chart operating line (i.e., the

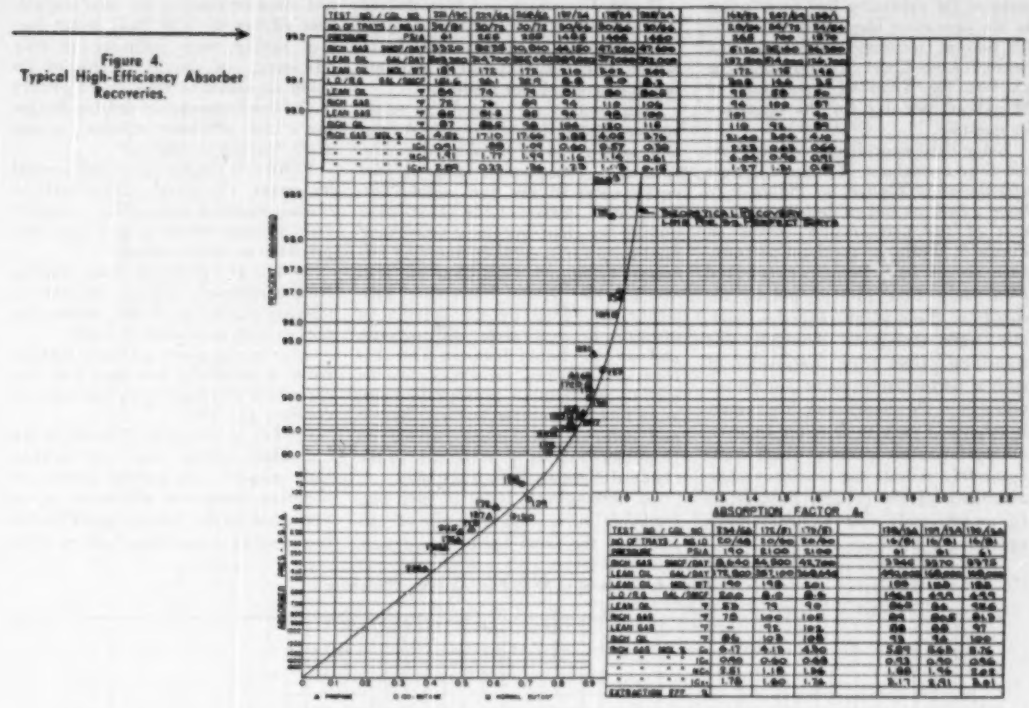


Figure 4.
Typical High-Efficiency Absorber Recoveries.

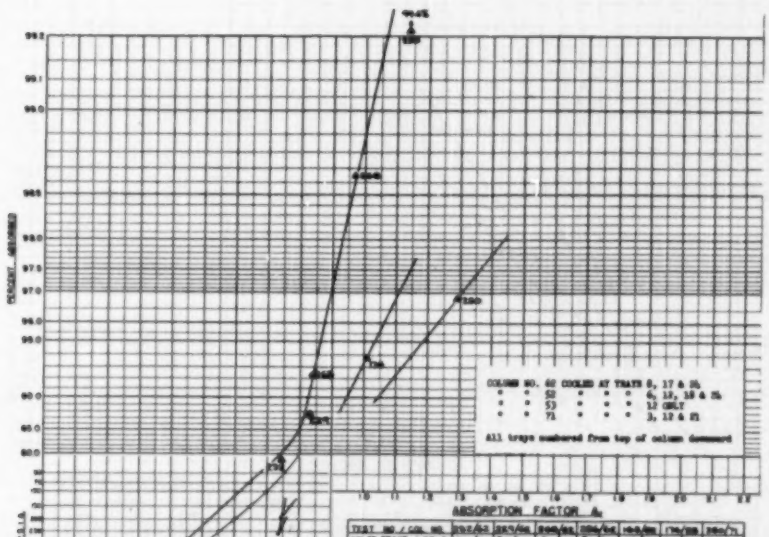


Figure 5.
High Propane Recoveries with Intercooled 195-265 Psia. Absorbers.

ratio of the operating line focal point to the operating line intercept on the 95 percent recovery ordinate of the Straight-Line Chart × 100) and the abscissa, the "Lean-Oil Circulation" in M gallons per day for the operation in question.

Using these coordinates, values from the four operations of Figure 8 were appropriately plotted on Figure 9 to form a background guide for construction of the performance curves on Figure 9. While the resultant performance curves have been constructed from only four plotted points, the spread of these points, and the generally well understood principle that transition values from one portion of such a performance curve plot to another must be made smoothly, makes it relatively easy to develop an overall performance pattern which quite accurately reflects the efficiency characteristics of the column in question for an extremely wide range of column operating conditions.

If added accuracy had been desired in the construction of Figure 9, additional runs could have been made, of course, under appropriately different conditions of column loading.

Both the original plotted test points and associated dotted vapor-load lines of Figure 9 can be considered as "intermediate construction material" for development of the final solid "Oil-Gas Ratio" curves of the chart—thus putting the chart into most convenient final form for general engineering reference. From such a chart one can read directly the Butane Extraction Efficiency developed by the column in question for any given oil-gas ratio and column liquid loading. This Extraction Efficiency value can then be used to construct an appropriate operating line on the Straight-Line Chart—and column calculations carried on from there exactly as in the case of the classical Kremser-Brown analysis.

By developing a series of such performance curves for a group of columns of the same basic tray design, and cross-correlating the resultant column efficiencies with those design factors having main influence on tray efficiency, one should be able to develop an excellent generalized picture of the requirements needed for designing a high efficiency column for any given loading condition.

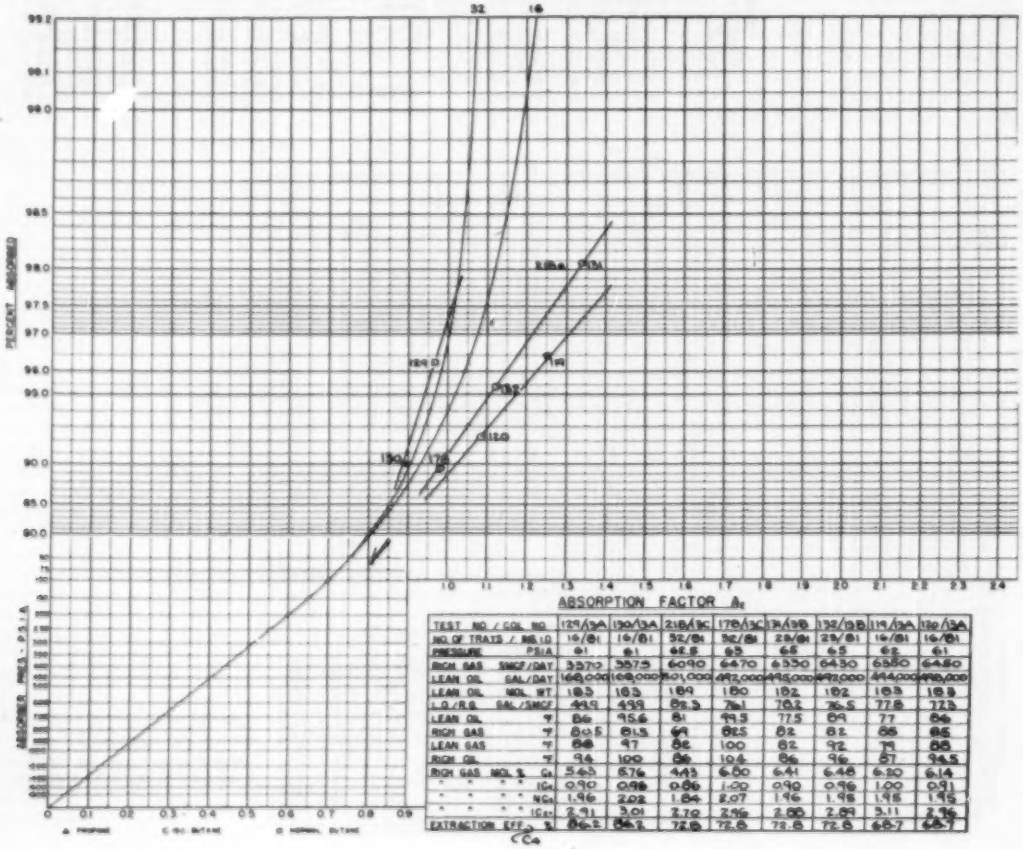
Figure 9 clearly illustrates several important efficiency relationships characteristic of most of the commercial columns which it has been our privilege to study, namely:

1) For any given gas load, starting from a relatively low oil load the extraction efficiency of the column decreases with increased oil load.

2) For any given oil load, starting from a relatively low gas load the extraction efficiency increases with increasing gas load.

3) For an oil-gas ratio to which the individual column trays are particularly adapted, only a small decrease in absorber extraction efficiency is experienced as the column gross load is increased to a maximum; on the other

Figure 6. Comparative 60-65 Psia. Absorber Efficiencies.



TEST NO / COL NO	129/13A	130/13A	218/13C	178/13C	134/13B	132/13B	119/13A	120/13A
NO OF TRAYS / RES. LD	16/81	16/81	32/81	32/81	28/81	28/81	16/81	16/81
PRESSURE PSIA	61	61	62.5	65	65	65	62	61
RICH GAS SMCF/DAY	3570	3575	6090	6470	6350	6430	6380	6480
LEAN OIL GAL/DAY	160,000	160,000	301,000	482,000	475,000	472,000	444,000	470,000
LEAN OIL MOL WT	183	183	199	180	182	182	183	183
L.O./R.G. GAL/SMCF	449	448	494.5	744	748	734.5	696	725
LEAN OIL °F	86	95.6	81	99.5	77.5	89	77	86
RICH GAS °F	80.5	81.5	69	82.5	82	82	86	86
LEAN GAS °F	88	97	82	100	82	92	79	88
RICH OIL °F	94	109	86	106	86	96	87	94.5
RICH GAS MOL % C_4	5.63	5.76	4.43	6.50	6.41	6.48	6.30	6.14
" " " " iC_4	0.90	0.98	0.86	1.00	0.90	0.96	1.00	0.91
" " " " nC_4	1.96	2.02	1.84	2.07	1.96	1.98	1.95	1.95
" " " " iC_5+	2.91	3.01	2.70	2.96	2.80	2.89	3.11	2.96
EXTRACTION EFF. %	84.5	84.2	72.8	72.0	72.6	72.6	68.7	68.7

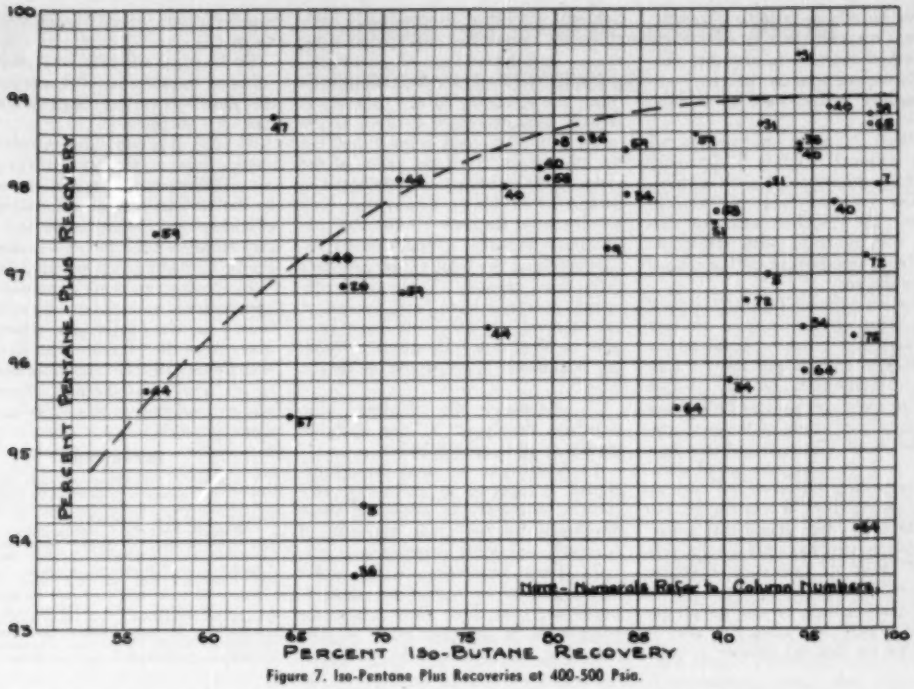
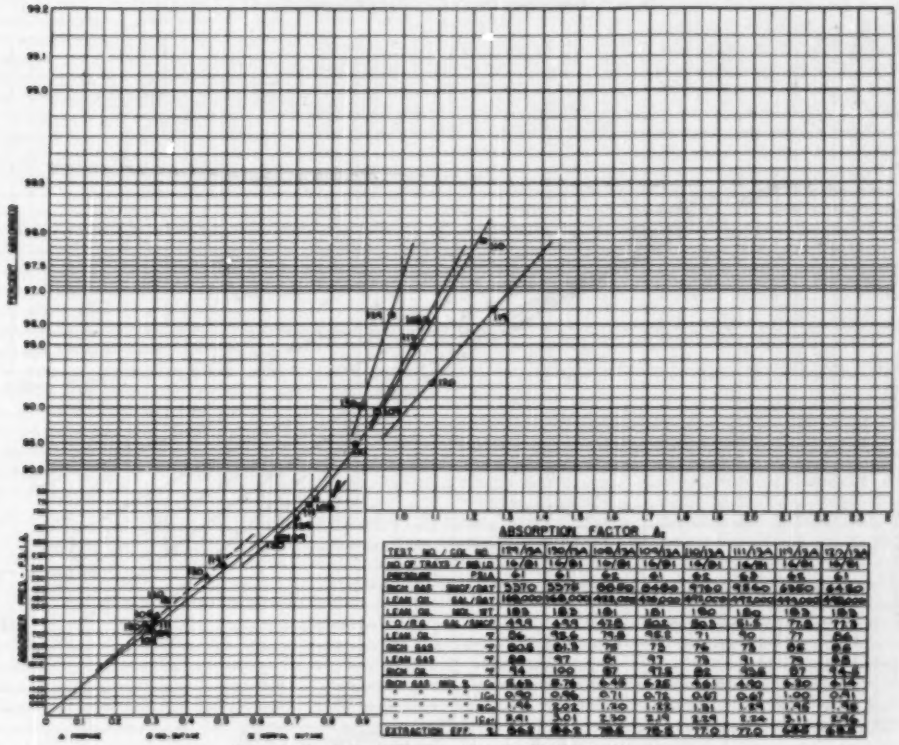


Figure 7. Iso-Pentane Plus Recoveries at 400-500 Psia.



TEST NO. / COL. NO.	119/32	120/32	108/32	109/32	110/32	111/32	112/32	113/32
NO. OF TRAYS / REB. LO.	16/81	16/81	16/81	16/81	16/81	16/81	16/81	16/81
PRESSURE PSIA	61	61	62	61	62	63	65	61
RICH GAS RMCF/BBL	33710	33778	06-09	04-09	9780	9860	6950	6480
LEAN OIL GAL./BBL.	440.000	440.000	440.000	440.000	440.000	440.000	440.000	440.000
LEAN OIL MOL. WT.	189	183	181	181	180	180	183	185
L.O./R.G. GAL./MMCF	455	455	438	805	805	81.5	776	77.8
LEAN OIL °F	86	95.6	75.8	95.5	71	90	77	86
RICH GAS °F	80.5	81.5	78	75	76	75	86	86
LEAN GAS °F	88	97	84	97	75	91	76	88
RICH OIL °F	94	100	87	97.5	82	93.6	87	94.5
RICH GAS MOL % C_1	84.69	84.78	84.48	84.36	84.61	84.90	84.30	84.26
" " " " iC_4	0.90	0.98	0.71	0.78	0.67	0.97	1.00	0.91
" " " " nC_4	1.46	1.02	1.50	1.52	1.31	1.54	1.46	1.48
" " " " iC_5	2.41	3.01	2.30	2.19	2.29	2.24	2.11	2.26
EXTRACTION EFF. %	96.8	96.5	78.8	78.8	77.0	77.0	68.8	68.8

Figure 8. "Bracketing" Operating Lines for 60-65 Psia. Absorber.

hand, for an oil-gas ratio to which the individual trays are poorly adapted, a very marked decrease in absorber efficiency is experienced as the gross column loading is increased to a maximum.

4) Down to some minimum oil loading (though Figure 9 does not indicate the presence of such a minimum for the particular column in question), the absorber extraction efficiency will increase with decreased liquid load, irrespective of the oil-gas ratio employed.

Mechanical considerations limited the capacity of the subject 16 tray perforated-plate column to something over 500,000 gallons per day of lean oil, and 10,000 mcf. per day of rich gas. With these mechanical limitations in mind, a brief study of the performance curves of Figure 9 indicate how foolish it is to make any broad statements regarding extraction efficiencies for any general type of tray design. For example, it is often stated that a perforated-plate tray has only a relatively narrow range of operating effectiveness; yet as long as we focus on the 50 gallons per mcf. or smaller oil-gas ratio to which this particular tray is suited, we see that the column in question will exhibit an exceptionally high efficiency over its entire operating range—and that in contradiction to the generally held opinion regarding such trays, *the efficiency of the column increases with decreased loading as far as the minimum load point tested.* On the other hand, if oil-gas ratios of the order of 80 or higher are attempted to be carried on this particular tray, then a substantial decrease in absorber extraction efficiency is encountered before reaching the limit of the column's gross load capacity. These same efficiency contrasts have been present in all columns on which we have been able to observe a wide range of loading conditions—irrespective of design type.

To summarize the efficiency relationships developed by our absorber studies to date, would state:

1) Absorption columns can be designed to operate at extraction efficiencies markedly in excess of those developed by the great majority of currently operating commercial units.

2) When recoveries of the order of 90 percent or higher are desired, particularly in those cases where the component in question exists in considerable amount, employment of super-efficient columns is highly profitable.

3) Design of such super-efficient columns requires careful attention to the development of high individual tray efficiencies.

4) The Straight Line Chart technique offers an effective tool for studying existing column operations whereby the various factors influencing tray efficiency may be evaluated and properly employed for the development of really high-efficiency column designs.

In closing, we wish to express our appreciation and indebtedness to the many individuals and companies throughout the industry who have generously contributed both time and data to our work, and through whose help and encouragement this study has been made possible.

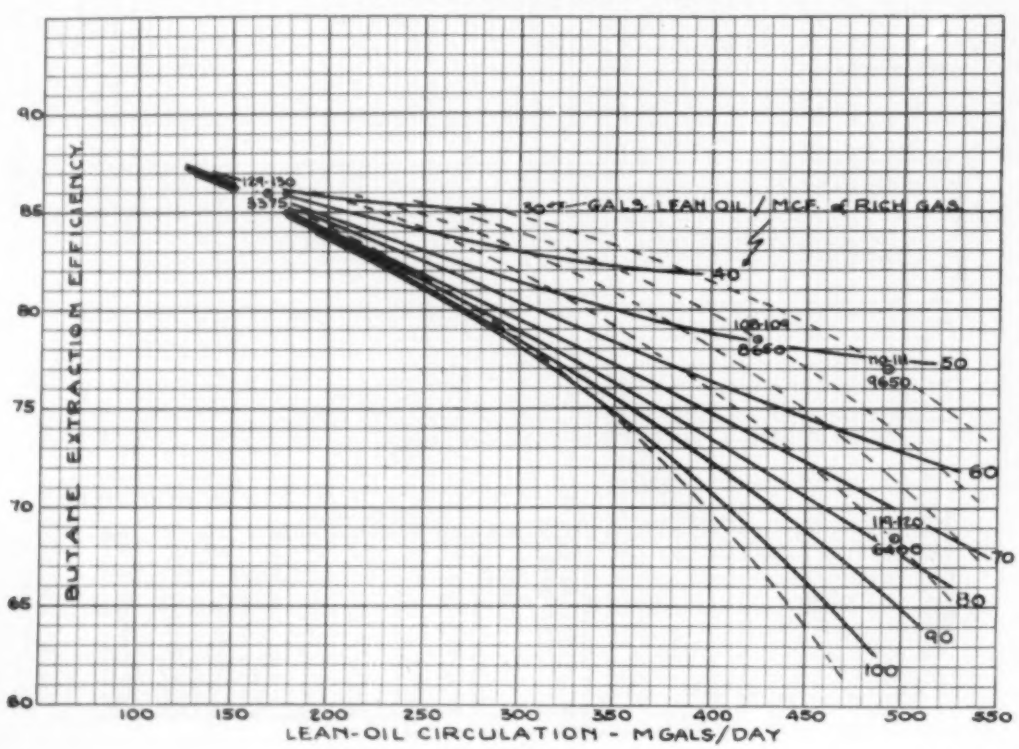
REFERENCES

1 "Evaluation of Absorber Operating Efficiency" by Ragatz and Richardson. Paper presented at 1946 Fall Meeting of the California Natural Gasoline Association.

2 "Straight-Line Chart Determination of Absorber Extraction Efficiency." Paper presented before a joint meeting of the Southern California Section of American Institute of Chemical Engineers and the California Natural Gasoline Association—December 10, 1947. Reprinted together with working curves in manual by Clark Bros. Co., Inc., Olean, N. Y.

3 "Design for Hydrocarbon Absorption and Stripping," by W. C. Edmister—Industrial and Engineering Chemistry, August, 1943.

Figure 9. Performance Curves for a 60-65 Psia. Absorber.



Testing Natural Gasoline Plant Operating Efficiency

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THE gasoline plant extraction efficiency test consists of several phases:

1) Preparation for the test.

2) Accumulation of operating data and samples for analysis during a period of steady operation of the plant.

3) Analysis of the results to show the accuracy of the data and reliability of the test. This is accomplished by gas and materials balances and by comparison of the test data with design or previous operating data.

4) Determination of extraction efficiencies, product losses, and inefficient and costly operations.

5) Recommendation of corrective measures necessary to obtain more efficient plant operations.

A good plant efficiency test has many important applications. It can be employed as a means of evaluating the operations of a new absorption plant to determine if the plant as a unit will meet the specifications for extraction set forth in the builders contract. It can be utilized as an aid to establish means of increasing efficiency of present plants or to determine the results obtained, after modifications have been made in them. The most important use for the test, however, is as a tool to periodically follow plant operations through years of steady production to eliminate operating inefficiencies and costly maintenance jobs.

Properly conducted, this test can be employed to gauge the necessary intervals between maintenance shutdowns and to indicate the probable time of replacement of inefficient equipment. It can be used as an aid for anticipating operating and plant maintenance costs.

Most companies do conduct an efficiency test of some sort at frequent intervals. Usually, these tests are spot checks on plant discharge streams to control absorption losses, or efficiency tests on separate units within the plant; and do not include an accumulation of data and analyses to determine over-all efficiencies. It is believed that the complete test should be conducted on every gasoline plant every twelve to eighteen months and that sufficient savings can be realized as a result to warrant these periodic tests.

Preliminary work getting ready for a plant test is just as important for a good test as accurate data and analyses taken during the test. Poor and inaccurate data often are a result of poor preparation.

The first step for an over-all plant test is to bring the plant flow chart up to date. This chart is a simple schematic flow diagram, which shows the normal flow of materials through the plant. All flow lines; including those which may be used only under abnormal conditions; by pass lines; flow controllers and meters; and all equipment pertinent to the gasoline absorption process are indicated. This is not an elaborate piping drawing, but a schematic layout and should be maintained continually for every gasoline plant. If a flow diagram does not exist, it is recommended that one be drawn up before the plant test is conducted.

The flow chart is checked for correctness by actual inspection of the plant lines and a careful study of the plant cycle is made. Sometimes this may reveal minor changes in the plant, which would effect increased operating efficiency. This is particularly true of plants where incorporation of modern design ideas will increase retention or in plants where many changes have been recently made and the plant cycle is not in the best order. This refers mainly to the disposition of plant vapor and condensate streams. Any obvious improvements within the plant should be recommended and, if possible, these changes should be made before the plant test is conducted.

When making plans for a plant test, field personnel should be contacted and notified of your plans. Sometimes it is best to set a date for the test that is mutually agreeable between both plant and field operators. Request the field operators to maintain, as nearly as possible, an average and steady gas load intake to the plant and to notify you of any upset conditions that otherwise be controlled for the period preceding and during the test. The field operators are quite willing to cooperate in every way they can, and this contact normally assures a much better condition for the plant test.

From the flow chart, it is possible to determine what samples and operating data will be taken during the test. At the time the chart is checked for correctness, sampling locations; thermometer wells; pressure gauge connections; and metering facilities should be noted. The first time that a test is run or after modification of the plant, there are always additional connections and thermometer wells that will be required during the test. It is best to request installation of these considerably ahead of any test date to give the plant maintenance crew time to get the work done.

For an over-all plant efficiency test, samples are required for analysis on all plant intakes, products, and discharge streams, including any rectifier residue or plant vapors to the plant fuel system. It is recommended, also, taking samples of any intra-plant streams that may indicate operating efficiency. These normally include absorber intakes, recycle vapor streams, and rectifier reflux streams. In addition, if the efficiency of any individual unit is to be determined concurrently, samples will be required around this unit. All samples are taken in accordance with standard sampling procedure. Analysis of the samples of the products and plant discharge gases are determined by fractional distillation. Analysis of the intakes and other plant streams can be determined by fractional distillation or by the charcoal enrichment test.

On low pressure and vacuum streams, sufficient volume of sample cannot be obtained in regular sample containers to conduct a charcoal test on a composite 24-hour sample. If these analyses are to be determined by the charcoal method, the tests must be run from spot line samples during the plant test period. In this case, analyses should be

THIS SUBJECT covers a large field when considering the role of the chemist and laboratory in efficient natural gasoline plant operations. Almost all tests employed by the chemist in the natural gasoline industry are tools for determining the operating efficiency of some part of the plant. This paper is limited to a report of a test procedure to determine the over-all plant operating efficiency as it applies to extraction of LPG and gasoline in the absorption plant only. It was originally presented at the recent 25th Anniversary meeting of the California Natural Gasoline Association.

Table 1A

Plant Test Data Summary Sheet

Plant ..... Date: Sept. 12, 1950. Observers: DBJ-DLT-JBA. Time: 6 A.M. to 6 A.M.

INTAKES	Meter No.	Gas Volume Mcf./D.	CONDENSATE Gal./Day		PRESSURE PSIG		TEMPERATURE °F.		Water Content Mcf./D.	ENRICHMENT	
			Gaso.	Water	Avg.	Variation	Avg.	Variation		Test	G/M
High Press. Field	241	20,800	.....	.....	440	432-451	103	86-125*	66	Chare.	0.84-0.52
Reduced H. P. Field	242	22,260	.....	.....	131	124-137	96	73-123	131	Chare.	1.01-0.98
Low Press. Field	243	2,936	.....	.....	7.5	5.8-9.1	84	67-109	78	Chare.	1.60-1.21
Totals		45,996	.....	.....	.....	.....	.....	.....	275	.....	.....

PLANT DISCHARGE	Meter No.	Gas Volume Mcf./D.	PRESSURE PSIG		TEMPERATURE °F.		Water Content Mcf./D.	ENRICHMENT	
			Avg.	Variation	Avg.	Variation		Test	G/M
Gas Lift	215	11,934	441	432-451	.....	.....	10	Chare.	0.91-0.51
Gas Lift	251	5,163	427½	420-432	96	85-112	37	Fract.	IC_4+ .086% IC_4 .063%
Absorber Discharge		26,900	423	415-428	99	82-105	2	Fract.	IC_4+ .22% IC_4 .05%
Rectifier Residue		316	278	275-279	112	None	49	.....	.....
Totals	.....	44,313	.....	.....	.....	.....	.....	.....	.....

PRODUCTS	Volume Gals. D.	Spec. R.V.P.	Sp. Gr.	Extraction G/M	Weath. Test Residue	Calc. Equiv. Gas Volume	Fract. Liq. Percent
Rect. Gasoline	26,869	29.7	.....	.93	.....	.....	C_3 .39 IC_4 12.83 NC_4 28.10 C_5+ 58.68
Totals	.....	.....	.....	.....	.....	.....	.....

GAS BALANCE INTAKES	Volume Mcf./D.	Water Content Mcf./D.	Plant Discharge	Volume Mcf./D.	Water Content Mcf./D.	Products	Equivalent Volume Products Mcf./D.
H. P. Field	20,800	66	Gas Lift 215	11,934	10	Rect. Gaso.	721
R. H. P. Field	22,260	131	Gas Lift 251	5,163	32		
L. P. Field	2,936	78	Absorber Discharge	26,900	2		
.....	.....	.....	Rect. Residue	316	.....	.....	.....
Totals	45,996	275	.....	44,313	49	.....	721

Gas Balance: Water Free Basis

Intakes: 45,721 Mcf./D. Difference 736 Mcf./D.

Discharge & Products 44,985 Mcf./D. 1.64 Percent

Dry Gas Ratio Discharge Gas Volume Mcf./D. Intake Gas Volume = .892764 Percent

MATERIALS BALANCE ISO BUTANE PLUS

Intakes	Volume	G/M	Factor	Iso But. Plus Gals./D.	Discharge and Products	Volume	G/M or Percent	Factor	Iso But. Plus Gal./D.
H. P. Field	20,800	0.84	.97	16,910	Gas Lift	17,097	0.91 G/M	.96	14,922
					Abs. Discharge	26,900	.086 Percent		760
R. H. P. Field	22,260	1.01	.963	21,930	Rect. Res.	316	.22 Percent	.....	24
					Gasoline	26,897	99.61 Percent	.....	26,764
L. P. Field	2,936	1.60	.996	4,680	.....	.....	.....	.....	.....
Totals	.....	.....	.....	43,190	.....	.....	.....	.....	42,470

Intakes 43,190 Gals. Discharge and Products 42,470 Gals. Difference 720 Gals. 1.67 Percent

ISO BUTANE EXTRACTION EFFICIENCY

PRODUCTS	Percent IC_4	Volume	Iso But. Gals./D.	Equivalent Volume Iso But. Mcf./D.	Discharge	Volume Mcf. D.	Iso But. Percent	Iso But. Mcf./D.
Gasoline	12.83	26,869	3,447	105.42	Absorber Discharge	26,900	.063	16.95
					Rect. Residue	316	.35	.16
Totals	.....	.....	.....	105.42	.....	.....	.....	17.11

$$\frac{\text{Iso Butane in Products } 105.42 \text{ Mcf./D.}}{\text{Iso Butane Products and Discharge } 105.42 + 17.11 \text{ Mcf./D.}} \times 100 = 86.1 \text{ Percent Iso Butane Extraction Efficiency}$$

Remarks: Plant Potential—Iso Butane 4010 Gals./Day (105.42 Mcf./D.).
Iso Butane Loss in Discharge Gases 553 Gals./Day (17.11 Mcf./D.).

taken on the intakes at times of maximum, minimum, and average enrichments, and the average of all three is used for the plant materials balance.

Sample containers should be set in place well ahead of the test. Large LPG cylinders are used for gas samples. Duplicate samples are taken, if possible, to limit the possibility of losing a sample. Cylinders should be steamed and evacuated, then checked for leaks before being used. Cylinders are hooked up to sampling connections with a short header to prevent danger of condensation in the header system. Each header is equipped with a pressure gauge for determining cylinder pressures during sampling. The header is flushed out with gas and then left connected to the sample line during the entire test. A shipping tag is attached to each container showing the time of sampling, the cylinder pressure for each increment of sample and other pertinent data regarding the sample. The tag is then initialed after each sample increment is taken.

If possible, the cylinder should be set in a shaded spot to protect from changing atmospheric conditions. The heat from open sun will cause changes in pressure on the sample containers between increments and may result in non-uniform samples being taken.

Liquid sample containers are hooked up in the same manner. All liquid samples are taken by water displacement and a measuring cup, to gauge the draw off for each sample increment, should be placed with the bomb at each sample point.

Drips that come into the plant with the intakes and accumulated in intake scrubbers, or that are collected through a separate gathering system, must be

gauged and sampled during the test.

All orifice meters used for measuring volumes of plant streams must be cleaned, calibrated, and checked prior to the plant test. Static readings on all meters must be checked against a test gauge on the line. New gravity and temperature factors are obtained and meter coefficients are recomputed, if necessary, based on the new data. Orifice plates must be checked to see if the size is correct and within the recommended range for accurate readings. If there is any question as to the size and condition of the orifice plates, they should be pulled and inspected. There is a possibility that the plate may be fouled or corroded, or that sand, line scale, or other matter may have accumulated behind the plate, resulting in a wrong reading.

Experience has shown that failure to check meters and plates thoroughly has resulted in some unsatisfactory plant tests. If one reading is incorrect, the plant materials balance will not check and the final results are questionable. Always question any plant measurement before the test and you will be more likely to obtain good test results.

Pressure gauges, thermometers, recording and controlling instruments, etc., are all calibrated against standard instruments prior to the test. A separate gauge or thermometer should be placed at every location where readings will be taken to avoid moving these instruments during the test. Check that all thermometer wells extend into the flow streams and give accurate readings. Be sure all gauge cocks and thermometer wells are not plugged.

All flow controlling equipment must be inspected to see that it is operating properly. Bypass valves should be inspected to be sure they are correctly open or closed.

Data readings and samples are taken every four hours during a plant test. For ease and speed in taking the data, a test work sheet is prepared. Each reading, sample, or other item required during the test is listed in the order in which it will be taken on each successive round of the plant. The work sheet is built by making an inspection

Table 18

Plant Test Data Summary Sheet—(Continued)

Plant _____ Date: Sept. 12, 1950. Observers: DBJ-DLT-JBA. Time: 6 A.M. to 6 A.M.

PLANT ACCUMULATOR DATA	Gas Volume Mcf./D.	CONDENSATE Gals./Day Gaso.	Water	PRESSURE PSIG. Avg.	Variation	TEMPERATURE °F. Avg.	Variation
Boosted L.P. Field		1700		82	78-85	79	70-87
Boosted R.H.P. Field		No.1-Neg.					
		No.2-2900		447	442-451	82	74-89
Mix Tank				100		83	
H.P. Vapors	575	11,700		435	427-446	76	67-89
Gasc.-Water Sep.		18,000		28	28-28½	77	69-83

ABSORBER DATA	Avg.	Variation	Avg.	Variation	Avg.	Variation
No.	1					
Type	Bubble Cap					
No. of Plates	24					
Service	H.P. Field					
Pressure Psig. Gas In						
Gas Out	423	415-428				
Gas Volume In						
Mcf./D. Out	26,900					
Gas Temperature In	97	86-112				
°F. Out	89	82-106				
Oil Circ. Gal. Per Min.	290					
Gal. per Mcf.	14.3					
Lean Oil Factor Clo	18.5					
Oil Temperature In	79	74-86				
°F. Out	105	96-117				
Shrinkage, Percent	7.8					
Iso Butane Abs. Factor	.98					

Stripper Data: No.	1					
Type	Bubble Cap					
No. of Plates Top Sect.	30 Total					
Bottom Sect.						
Pressure Psig.	32½	32-32½				
Oil Circ. Gpm.	290					
M. Gal./Day	417					
Steam Pressure Psig.	34½					
Volume Lbs./Day	75,800					
Lbs./1000 Gal. Oil	182					
Temperature Oil In	358	None				
°F. Top	394	391½-395				
Bottom	344	342-346				
Stripping Factor	1.75					
Lean Oil Gravity	36.3					
V.P. am. H_2O at 100 °F.	33					
Reflux Gal./Day	57,500					
Reflux Ratio	1.6-1					
Calc. Lovp. Gal./Day	178					
Actual Lean Oil Loss G/D	278					

Rectifier Data: No.	1					
Type	Bubble Cap					
No. of Plates	24					
Control Plate						
Pressure Psig.	285					
Temperature, Feed	206					
°F. Control	141					
Top						
Reboiler	299					
Feed Rate, Gal./Day	36,500					
Reflux Rate, Gal./Day	42,000					
Reflux Ratio	1.15					
Reflux Temperature °F.	112					
Wenth. Test Residue %	.54 IC4+					
Volume Residue Vapors	316					
Disposition of Vapors	Boiler Fuel					
Top Liquid Product	None					
Volume Gal./Day						

Cold Oil Vent Tanks:	1	2
Temperature °F	103	
Pressure Psig.	185	
Residue	955	
Disposition of Vapors	To Boosted L.P. Int	

HEAT EXCHANGERS: Type				
Arrangement	Parallel			
Temperatures °F:	**1**	**2**	**3**	**4**
Lean Oil To	337	343		
Lean Oil From	159	165		
Degrees Drop	178	178		
Rich Oil To	103	103		
Rich Oil From	271	267		
Degrees Pick Up	168	164		
Pressures Psig.:				
Lean Oil To	26	32		
Lean Oil From	16	16½		
Pressure Drop	10	15½		
Rich Oil To	153	181		
Rich Oil From	103	115		
Pressure Drop	50	66		

Calc. Lean Oil Heat Load Btu./Hr. 12,100,000
Calc. Rich Oil Heat Load Btu./Hr.
Heat Loss in Lean Oil Coil Btu./Hr., 3,565,000

Hot Oil Vent Tanks:	1	2
Temperatures, °F.	271	267
Pressures Psig.	101	115
Disposition of Vapors	To H.P. Vapors	To H.P. Vapors

Preheaters: Type				
Arrangement	Parallel			
Temperature °F. Oil To	271	267		
Oil From	358	354		
Pressure Psig. Oil To	54	60		
Oil From	37	38		
Pressure Drop Psi.	17	22		
Steam Pressure Psig.	184	184		
Temperature °F.	375	375		
Heat Pick Up °F.	87	91		
Approach to Steam °F.	17	17		

	1		2	
Rect. Heat Exchangers:	**Temp. °F.**	**Press. Psig.**	**Temp. °F.**	**Pres. Psig.**
Feed To	83	392		
Feed From	206	290		
Temp. Rise-Press. Drop	123	2		
Product To	206	285		
Product From	134	282		
Temp. Drop.-Press. Drop	162	3		
Heat Transfer Btu./Hr.				

Cooling Conditions:	Avg.	Variation	Avg.	Variation
Wet Bulb Temp. °F.	58	52-63		
Dry Bulb Temp. °F.	72	62-83		
Wind Vel. Mpb. and Direct.	3-5 Mph. at Rt. Angles to Tower			
Tower	Process			
Volume Spray Water Gpm.	3900			
Volume Spray Per Section				
Spray Temperature °F.	80	72-83		
Basin Temperature °F.	91½			

Cooling Coils:	Hot Temp. °F.	Cold Temp. °F.	Spray Temp. °F.	Approach To WB
L. P. Gas	212	92	85	34
H. P. Gas	248	88	78.5	20.5
L. P. Vapors	148	88	74	20.5
H. P. Vapors	194	86	83.5	38
Stripper Vapors	201	92	83	34
Lean Oil	161	77	72	19

of the plant, recording each point at which data will be required in the order in which they are reached. There is one column for each round of data. This enables the readings to be taken in the same order each time. It eliminates jumping around on a data sheet, hunting the line on which some reading is to be recorded. It prevents missing data and it makes the readings much quicker and easier to obtain. The time of starting and completing each round of the plant is recorded.

After the preparation for the test is completed, one inspection of the plant is made, taking all data readings and checking sample containers to be sure everything is satisfactory. When making plans for your plant test, schedule your work so that you will have plenty of time both for preparation and during the test to complete everything required. Allow time to take care of unforeseen difficulties. Don't schedule too much work for the day of the test. It is better to get the essential data accurately than to plan too much and not be able to complete it.

Normally, the plant test is conducted over a 24-hour period, from gauging time one morning till the same time the next morning. Shorter tests are not recommended because variations in atmospheric conditions and intake enrichments, which cannot be controlled, might give erroneous results. At the start of the test, gauges are taken on all gasoline, LPG, and lean oil storage. If products are shipped by meter, these readings are also taken. Levels in all plant accumulators and surge tanks must be marked. It is recommended that the plant operators be requested to maintain these levels as nearly as possible at the same point during the test. At the end of the test, corrections must be made in the materials balance to account for any change in volumes in the condensates in the plant accumulators.

After the morning gauge has been made, the first round of data is taken. When a complete set of data is obtained, the work sheet is studied and any data which appears to be out of line should be rechecked immediately.

During the test, it is necessary to gauge the rate of condensate, both gasoline and water, in the various plant accumulators. This normally requires shutting in the vessel and gauging the rise of condensate over a period of time. It is not necessary to gauge these accumulators every time data is taken during the test, but it should be done at previously estimated times of maximum, minimum, and average rates.

At the end of the test period, final gauges are taken on all storage tanks and accumulators. Any changes in volume of condensate in the plant accumulators must be determined.

Sample containers are disconnected and checked for leaky valves. Analyses are determined as time permits.

All recording charts are accumulated and kept with other plant test data for reference.

Data Summary Sheet

A summary of all test data is recorded on the data summary sheet, a copy of which is attached. The first section of the sheet summarizes all data necessary to compute the gas and materials balances and the over-all iso-butane extraction efficiency. The remainder of the sheet summarizes all operating data.

All volumes entered are corrected to 60° F., and where these readings are obtainable from 24-hour recording charts or gauges, they are utilized. The average of all readings and the variation in these readings during the test are recorded under operating data.

The plant gas balance can be computed prior to the receipt of sample analyses to indicate the reliability of the test data. This is computed on a water free basis, assuming saturated gas streams at all points. The gas balance compares the total of the plant intake volumes with the sum of the plant discharge gas volumes and the gas equivalent volume of the products. This balance should normally check within 3 percent. This deviation is due to inaccuracy of measurements. Any greater deviation indicates erroneous measurements or losses within the plant.

An over-all plant materials balance is computed after all sample analyses have been obtained. If fractional analyses have been determined on all samples, this materials balance is made for each component of the gas. If charcoal enrichment tests have been run on the plant intake samples, the balance is computed on the iso-butane plus fraction only. For greater accuracy in this case, a small correction factor is applied to the charcoal test result to indicate iso-butane plus only. The materials balance should check favorably with the preceding gas balance. Any large deviation between the two indicates incorrect analyses or that measurements, particularly of the products, may be in error.

The plant potential and the over-all extraction efficiency can now be computed for any component: propane, iso-butane, or for any desired Rvp. gasoline. For these calculations, the analyses of the discharge gases and products are used because these data are normally more accurate than the plant intake data. The potential for any component is the total volume of that component available for extraction in the plant. The potential is determined by computing the total volume of the desired component in the discharge gases and the products.

The over-all extraction efficiency for any component is then indicated by the ratio of the actual production to the plant potential. This is determined by dividing the volume of the desired component in the products by the total volume of the component in the products and discharge gases.

The accompanying data sheet (split into Tables 1A and 1B) shows some of the plant operating data from a recent test. During this test, a gas balance was obtained with a difference between intakes and discharge streams of only 1.64 percent. The materials balance for iso-butane plus showed a difference of 1.67 percent. This is an excellent check and indicates that the volumes and analyses, as determined for the test, are accurate. From these data then, an iso-butane potential of 4010 gallons per day is shown and an over-all iso-butane extraction efficiency of 86.1 percent for the plant has been determined.

Although the objective of the test is to establish the over-all extraction efficiency of the plant, much of the value of a test of this type comes from the plant operating data obtained. After the summary of the data has been completed, readings are compared with previous test data or with design figures. Differences between these figures may point out definite operating inefficiencies, such as costly steam or heat losses, inefficient heat transfers due to fouling, and possible product losses.

Plant cycle calculations furnish another means of checking the accuracy of the plant test data. Computation of the flow cycle using intake compositions, and temperature and pressure data obtained during the test should check very closely with determined operating efficiencies and volumes and analyses of the products, discharge gas and recycle vapor streams. These calculations may indicate operating inefficiencies which are not otherwise apparent.

The final phase of the plant test is to make recommendations for changes in the plant, which will correct the operating inefficiencies and/or increase extraction. These changes will vary from minor improvements to large scale plant modifications. The payout of the plant test is obtained when these recommendations are carried out and increased operating efficiencies are realized. These are the savings that will warrant additional plant tests in the future.

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- Butyric Acid
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- Acetanilide
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REFINER AUTHORS and Other Personalities

Information, formal and otherwise, about the men who write for PETROLEUM REFINER as well as others prominent in the industry.

Australian-Born Boyd Heads Mines Bureau

BORN IN 1904 at Kanowna, western Australia, Dr. James Boyd, author of "Petroleum Industry Has Definite Role in Synthetics Development," which appears on page 77, spent his early years in schools in England and the U. S.

Now director of the U. S. Bureau of Mines, Washington, D. C., Dr. Boyd was appointed to that position in 1947, after serving as special assistant to the Secretary of Interior earlier that year.

Receiving a B.S. degree in engineering and economics from the California Institute of Technology in 1927, he then received an M.S. degree in geophysics and a D.S. in geology from Colorado School of Mines in 1932 and 1934, respectively.

During summer months, he worked as field engineer in geophysics; field geophysicist; consultant in geophysics; geologist; and consultant in geology, mining, and geophysics.

Dr. Boyd has served as secretary and manager of the Denver Electronics Company and president and general manager of the Goldcrest Mining Company. He taught at the Colorado School of Mines from 1929 until 1941, becoming associate professor of economic geology.

After serving with the Army during World War II, he became dean of faculty at the School of Mines, from which position he was appointed special assistant to the Secretary of Interior.

During the war, he used his knowledge of minerals in various military assignments and was U. S. representative on committees of the Control Council for Germany. For his work, he received the Legion of Merit award, with oak leaf cluster.

Hundreds of Articles To Egloff's Credit

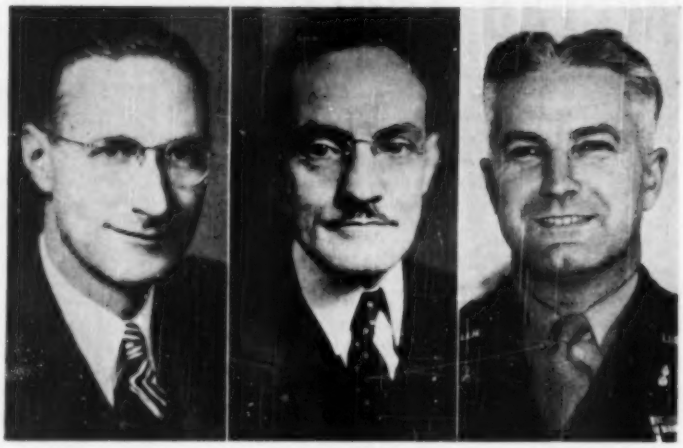
DR. GUSTAV EGLOFF, whose article, "Adequate Protection NOW of Strategic Oil Supplies Urged," appears on page 104, is the author of some 300 articles relating to the petroleum industry and the chemistry of hydrocarbons, particularly the cracking and refining of oil.

Employed by Universal Oil Products Company as director of research since 1917, he holds several hundreds of patents in the U. S. and abroad relating to the processing of petroleum oil, coal, shale oil and chemical derivatives of hydrocarbons.

Born in New York City, Dr. Egloff was graduated with an A.B. degree by Cornell University in 1912. He received a master of arts degree from Columbia University in 1913 and a Ph.D., 1916.

In 1915 and 1916 he served with the Bureau of Mines and the Aetna Chemical Company, cracking oil experimentally and commercially.

He is a member of numerous scientific societies and petroleum industry organizations.



Dr. James Boyd | Dr. Gustav Egloff | Col. B. S. Mesick

Col. Mesick Received His Degree from MIT

COLONEL Benjamin S. Mesick, chief of the Bureau of Research and Materials Branch, Ordnance Research and Development Division, Office of the Chief of Ordnance, Washington, D. C., is author of the articles on page 88, "Fuels and Lubricants Needs Cited by Army Researcher."

Prior to entering the U. S. Military Academy in 1920 Col. Mesick attended Cornell University and received his D.Sc. from Massachusetts Institute of Technology in 1938.

During his military career, he has been awarded the Legion of Merit, the oak leaf cluster, the Order of the British Empire, and the French Croix de Guerre with Palm.

Military assignments have included the Coast Artillery Corps; teaching at West Point; office of the Chief of Ordnance; ordnance officer; commanding officer; ordnance planning and preparation for invasion of the Continent; officer-in-charge of the Ordnance Research and Development Sub-Office (Rocket) at California Institute of Technology; and commanding officer of the Sierra Ordnance Depot, Calif.

Attended Standard's First Sales School

OIL Industry Would Aid U. S. in Safeguarding Its Freedom," which appears on page 71, was written by the general manager of sales of Standard Oil Company (Indiana), Dwight F. Benton.

Benton advanced to this position and that of director in 1949 when Pan American Corporation of New Orleans, a Standard subsidiary, and Root Petroleum Company of Shreveport, merged to form Pan-Am Southern Corporation. He had been made president of Root in 1948.

Joining Standard Oil Company (Indiana) in 1923, Benton was a member of the first sales engineering school at its Whiting, Ind., refinery. He became a salesman at Duluth, Minn., in 1924; transferred to the Midwest Refining Company, a former subsidiary of the company, in 1929; and served as a sales promoter at Denver and the Chicago general office for Standard in 1930.

Then after serving as assistant manager at Denver for three years, he became manager in 1934. In 1939 he became manager of the Rocky Mountain sales division and in 1946 was promoted to assistant general manager of sales for the Rocky Mountain division with headquarters at Denver.

Later in 1946 Benton became assistant general manager of the lubricating and sales technical service department in the general office of Standard of Indiana at Chicago and in 1947 was advanced to general manager of those departments.

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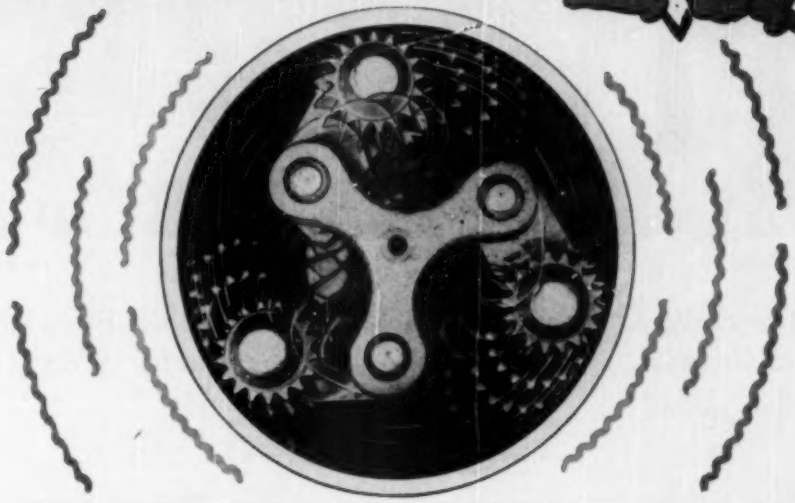

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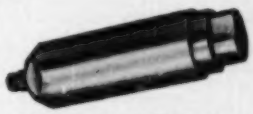

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EDW. G. RAGATZ | W. F. FULTON | J. B. ARMSTRONG | R. E. PENNINGTON

Ragatz Enjoys Work In Natural Gasoline

EDWARD G. RAGATZ, who calls natural gasoline processing his favorite hobby, does general consulting work for this industry in addition to his association with J. B. Gill Company, Los Angeles, in the design and construction of all types of natural gasoline equipment. His article, "Efficiency Characteristics of Commercial Absorbers," appears on page 117. This is not his first article in PETROLEUM REFINER.

Leaving the University of California in 1917 for service in the Air Corps, he was mustered out in December, 1918, when he became employed for a time in steel mills. Returning to school, he was graduated in 1921 by Massachusetts Institute of Technology with a B.S. degree in mechanical engineering.

Immediately after graduation he joined the Union Oil Company and for 18 years concentrated on process research and development work, publishing a number of technical papers. In 1939 he became manager of the economics department of the company.

Temporarily deserting the petroleum field from 1942 to 1944, he assisted in the expansion of a specialty machine tool company which he and two associates had previously founded.

In 1944 he became liaison engineer with Bechtel Brothers-McCone Parsons on a war-time project at the C.P.I.M. refinery at Curacao, Netherlands West Indies. Subsequently he organized and headed a natural gasoline division for Bechtel-McCone.

As to an interest in sports, Ragatz enjoys hunting and fishing, particularly duck hunting and trout fishing with his two sons.

Fulton Began Work With Refineries in 1920

W. F. FULTON, whose article "Platforming Natural Gasoline—Its Potentialities for the Natural Gasoline Industry" appears on page 109, has been manager of Warren Petroleum Corporation's Fairbanks, Texas, laboratory, for the past five years.

After studying chemical engineering at Louisiana State University, Fulton was first employed by Louisiana Oil Refining from 1920 to 1924. As a superintendent of light oil refining and lube oil refining, he constructed and operated a grease plant.

From 1924 through 1925, he was employed in New Orleans with Chalmette Refining Company doing refinery construction.

Later he was employed by Palmer Corporation, Shreveport, at its gasoline plants. From 1929 to 1930, he constructed eight carbon plants for Palmer Carbon Company in Borger, Texas. From 1931 through 1945 he was head of the natural gasoline and chemical department of United Gas Pipe Line Company.

He and his wife live in Bellaire, Texas. Their son is attending Union Theological Seminary in New York where he is working on his doctor of divinity degree. Their daughter is attending the University of Texas.

Armstrong Is Former Pharmacy Chemist

JOHN B. ARMSTRONG, who contributed the article, "Testing Natural Gasoline Plant Operating Efficiency," which appears on page 125, is district test engineer for the Natural Gasoline department of Standard Oil Company of California.

Educated at Ohio State University, he received a bachelor of chemical engineering degree in 1937 and a master of science degree in December, 1938.

In the spring of 1939, he went to California where he worked first as a chemist for a vitamin and pharmaceutical company and later as an engineer for a consulting metallurgical laboratory. During the war, he served in Africa and Europe with the 3rd Infantry Division.

He joined California Research Corporation in 1945, working on natural gasoline plant design and operating problems; and in 1948, he was transferred to the Natural Gasoline department as test engineer. In this capacity, he does process engineering and testing for the Southern district and assists the production superintendent in coordinating process and product control operations.

Robert Pennington Is Father to Baby Girl

ROBERT E. PENNINGTON, who collaborated with Kenneth A. Kobe to write the series of articles on "Thermochemistry for the Petrochemical Industry," is a physical chemist in the thermodynamics section of the U. S. Bureau of Mines at Bartlesville, Okla. Part XIV of the series, "Some Miscellaneous Hydrocarbons," appears on page 93.

Born in 1926, in Brenham, Texas, Pennington was graduated from Brenham High School in 1944 and joined the Navy. He was assigned to the Navy V-12 program at the University of Texas.

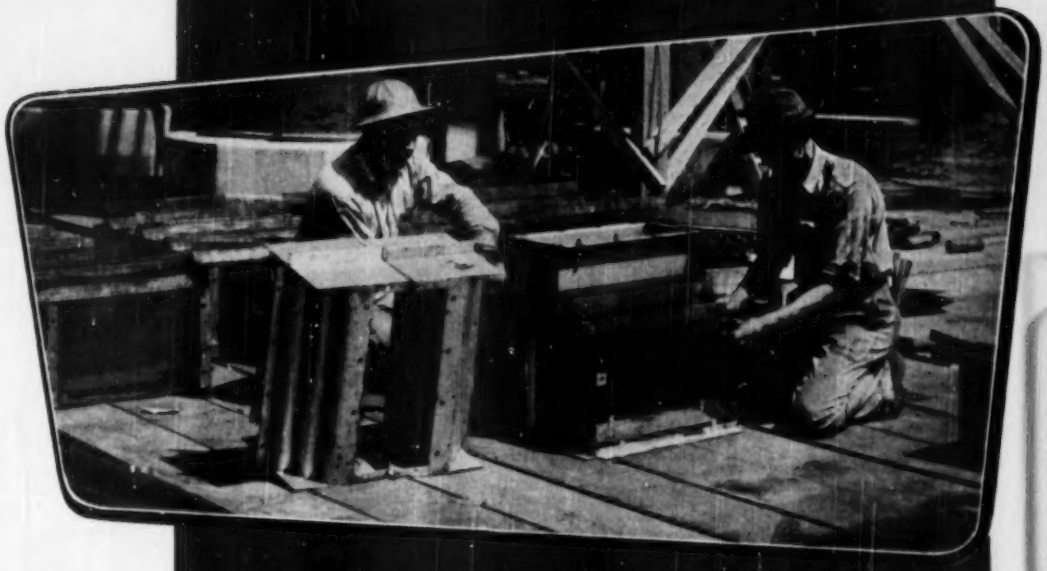
When discharged from the Navy in 1946, he continued at the University of Texas in chemical engineering and received his B.S. degree in 1948. He then enrolled in the graduate school to work for a master of science degree in chemical engineering.

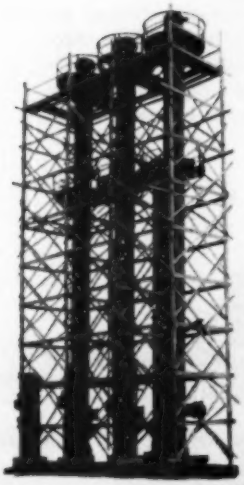
Taking all the advanced courses in chemistry dealing with quantum and statistical mechanics, he became skilled in this branch of physical chemistry. For his research project for his graduate work, he calculated the thermodynamic properties of nitrous oxide from the spectroscopic data. He held the Celanese Fellowship in Chemical Engineering and continued the preparation of thermochemical data for many compounds where only spectroscopic data existed.

He began his present work on thermochemical properties of petroleum compounds for the Bureau of Mines on July 15, 1950.

Married in December, 1946, Pennington recently became the father of a girl. chemical properties of petroleum complains of difficulties in locating fishing spots in Oklahoma.

NUMBER 2 OF A SERIES





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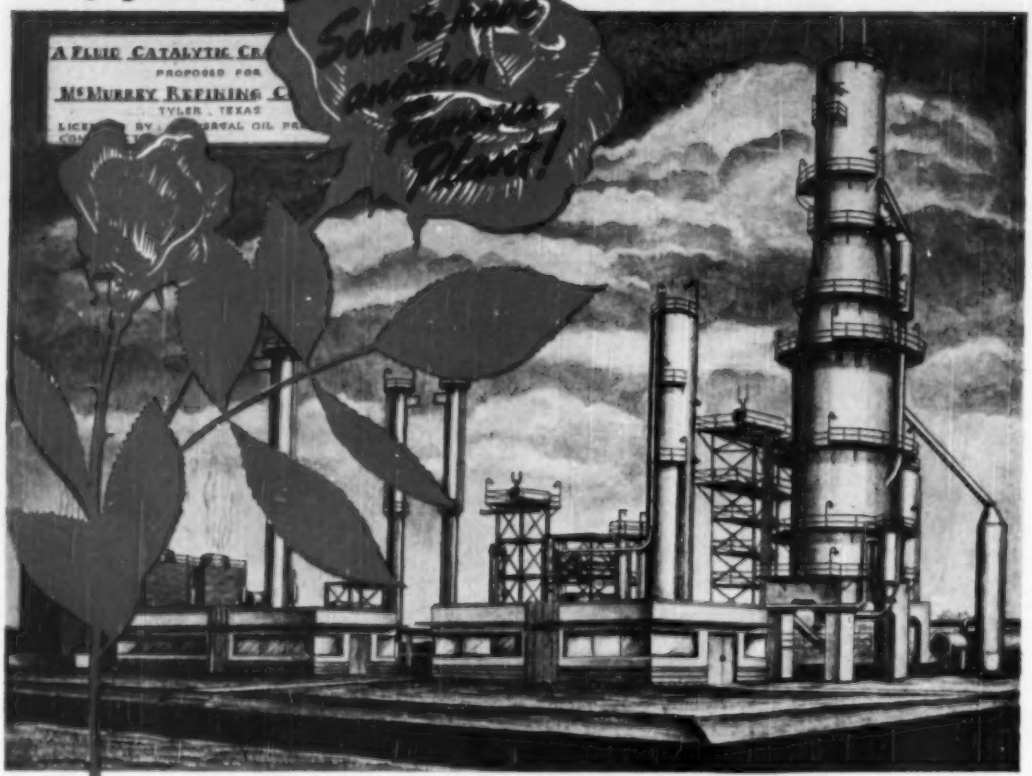

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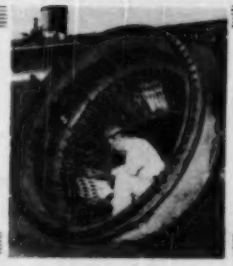
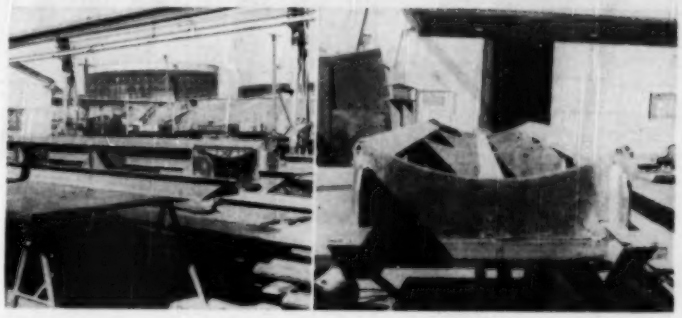


HOW—

Tube Bundle Cradle Aids Maintenance

HANDLING tube bundles of heat exchangers is being done with a tube bundle cradle in one refinery without damage to tubes, tube headers, or to the intermediate supports. The cradle is a steel unit built on a skid type base. Four risers, a solid one at each end, and two intermediate ones shaped to fit the structural steel. Two wide channel iron sections form the supports at each side upon which the tube bundle rests after being lowered into the cradle. Gusset plates welded to the sides of the panels, or risers, where they join the skid members stiffen the structure, prevent distortion. Plates welded at the corners at the junction of the skid members are perforated for attaching motor crane slings for lifting.



HOW CITIES SERVICE—

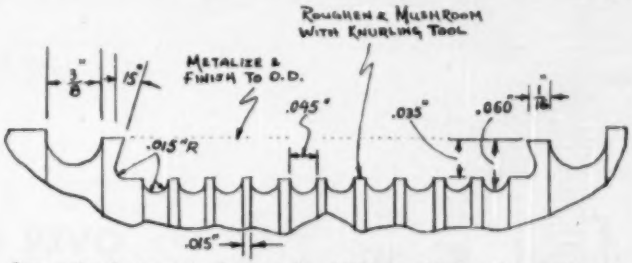
Repairs Turbo-Generator Shafts 'On the Spot'

DURING previous annual inspections of the power house turbo-generators engineers at the Tutwiler refinery of Cities Service Refining Corporation, Lake Charles, La., found that gradual erosion was taking place at the gland seal runner surfaces on the turbine shafts. Diameter of the shafts at governor end is 7 inches and at coupling end 10 inches. Since the shaft and blading rotor assembly are too large to "chuck up" in an ordinary lathe—the turbine rotor weighs 5000 pounds and the shaft assembly has a diameter or last stage wheel measuring 69 inches—there remained just two alternatives: Complete "on the spot" repairs, or ship the entire assembly some 300 miles and take chances of avoiding rotor damage in transit.

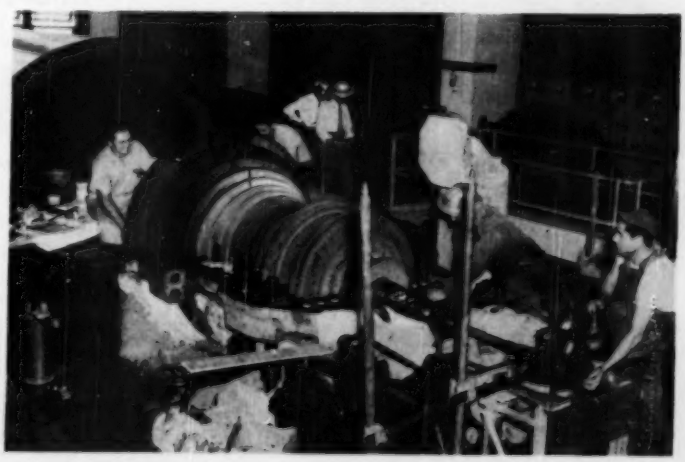
This last was discarded as impractical and repairs on the J-4 Turbine Gland Seal with the generator remaining in place were undertaken.

An air motor, geared drill of 20 rpm., rated at approximately 5 hp. with 100 psi. air, was used to turn the shaft while the eroded spots were removed by cutting a series of shallow grooves. Seal surfaces were cut down 1/16 inch and built up by metalizing to the original diameter (see cross section diagram).

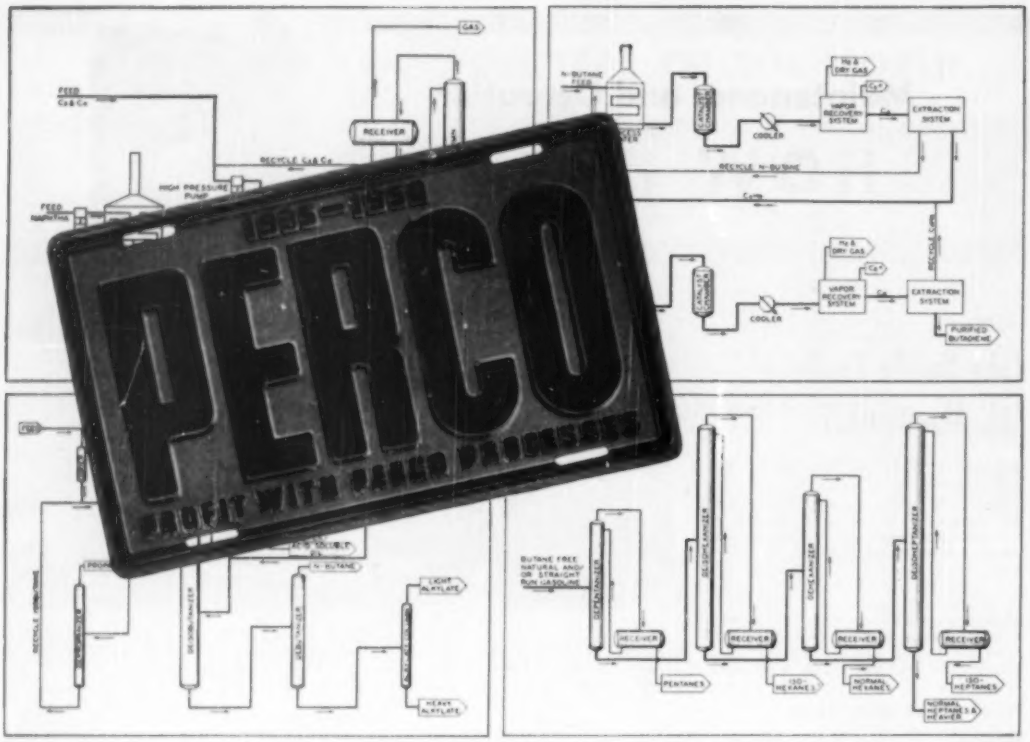
A mist of melted 18-8 stainless steel,



Cross section showing seal surfaces cut down 1/16-inch and built up by metallizing to original diameter.



Machinist Croom seems pleased with the progress of repairs as Machinist Jim Waldrum inspects a similar seal repair made at the high pressure end of the turbine shaft.



OVER 120 INSTALLATIONS —LICENSED BY PERCO*

Perco Processes are exceedingly flexible and widely applicable to many of the problems facing refiners today. Versatility of Perco equipment enables you to upgrade your finished product in line with market trends without resorting to heavy capital investment, elaborate instrumentation or high cost catalysts. For more background on Perco's achievements, call on us. We'll be glad to help you assess the potential increase in profits per barrel of your finished products through the utilization of proved Perco Processes.

*A SERVICE MARK

PERCO DIVISION
PHILLIPS PETROLEUM COMPANY
BARTLESVILLE, OKLAHOMA

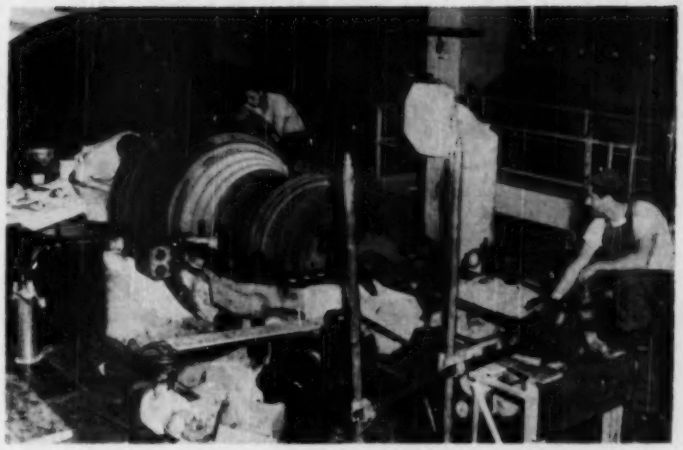
(very low carbon) wire applied with a metallizing gun was then deposited on the grooved shaft until the shaft was slightly larger in diameter than the original dimension. Melting point of the metal deposited is approximately 2610° F.

The stainless steel build-up was turned down to original shaft diameter to form a near perfect seal at the point where the main turbine shaft emerges from the casing.

Bottom bearing halves were left in place but covered with thin sheet lead for bearing surfaces to overcome the lack of forced feed lubricant and lifting effects of oil film. Frequent application of oil from an oil can was the only lubrication needed.

An estimated saving of $600 was made by repair in place with a saving of 180 man hours. (These figures do not include the saving due to reduction in machine outage, time, etc.)

Photographs and material by courtesy of G. N. Hebert, Cities Service Refining Corporation, Lake Charles, La.



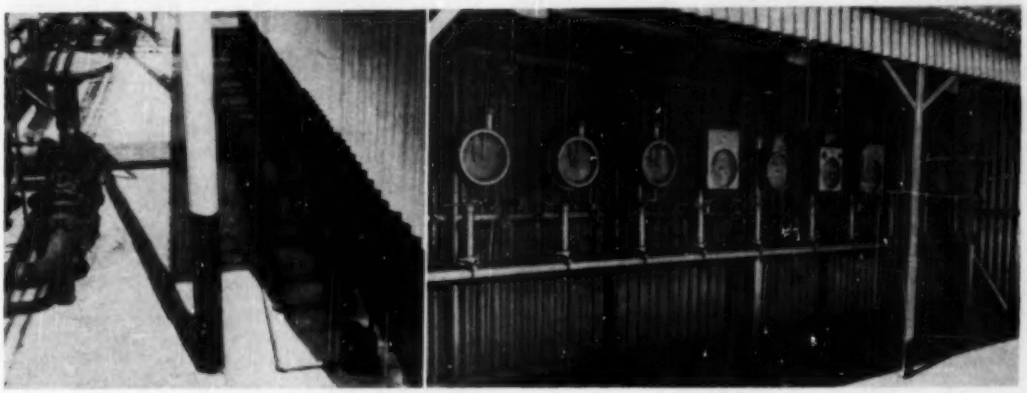
Upper right, Machinist Joe Venturella is at the throttle of air motor which turned shaft for cutting and metallizing. Machinist R. M. Croom, half hidden behind the last row of blading, is engaged in a cutting operation assisted by machinist's helper I. W. Fisk.

Lathe type cutting jig used for cutting and machine operations on the shaft.

HOW TO—

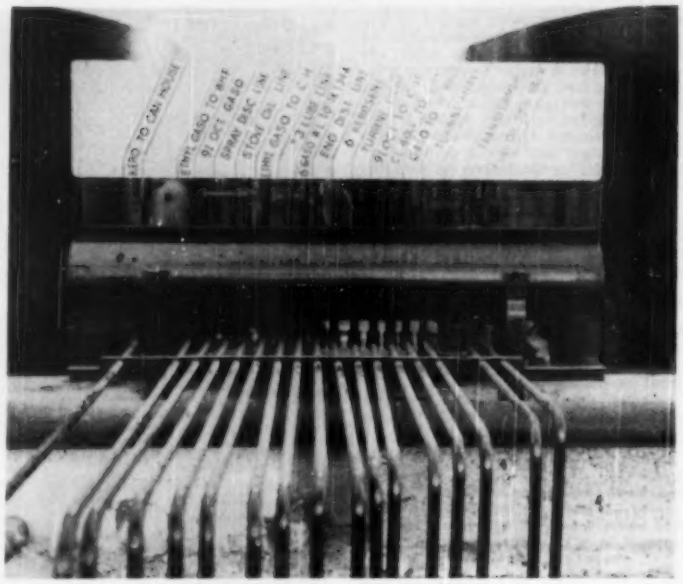
Make Drip-pots For Instruments

WESTERN States Gasoline Corporation has solved its problem of drip pots for recording instruments with a somewhat unusual installation. The instruments are grouped in one location on a "hitch-rack" type support of 4-inch pipe instead of on a conventional control panel. Three vertical posts set in the concrete floor support a horizontal pipe welded to the top of the risers. The instruments mounted on this top rail are supplied with pipe saddle



connections that include leveling set screws to retain the settings and to provide means of adjustment. Housed in an open-sided building, the instruments are provided with adequate light during the daytime. Illumination at night is supplied by flood lights.

The piping to and from the instruments converges at the rear of the instrument building. These lines are placed near the ground on permanent cribbing supports. The lines terminate in drip pots where each instrument is provided with two, one for each side of the mercury pot. The pots are made of 4-inch pipe about 5 inches long with flat heads and bottoms. Lines to the instruments connect to the bottom of the pots close to the base of the sides. Lines leading to the instruments inside the building leave the drip-pots at the top. A bleeder in the center of the top is used to drain the pots. The pipe extends through the top to approximately the bottom level. Needle valves are attached to the bleeders so a container can be set beneath the outlets to recover any mercury that might have pulled over from the instruments. Condensate and liquids can be recovered in the same manner.

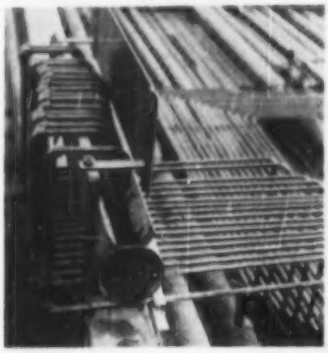


HOW—

Waste Receiver Serves Plant Product Lines

WHERE a group of product lines are laid beside each other, waste from test gates can be piped into a common disposal center. This method prevents spills and tends to maintain cleanliness in the plant area. Operators not familiar with the various pipe lines can open a test line to check the product, or to obtain samples in the line to check before pumping out to destination.

The waste receiver consists of a piece of 8-inch pipe with flat heads welded at each end. A 3-inch wide slot is cut in the top side of the receiver, after which 4-inch wings are welded on each side to serve as a funnel.



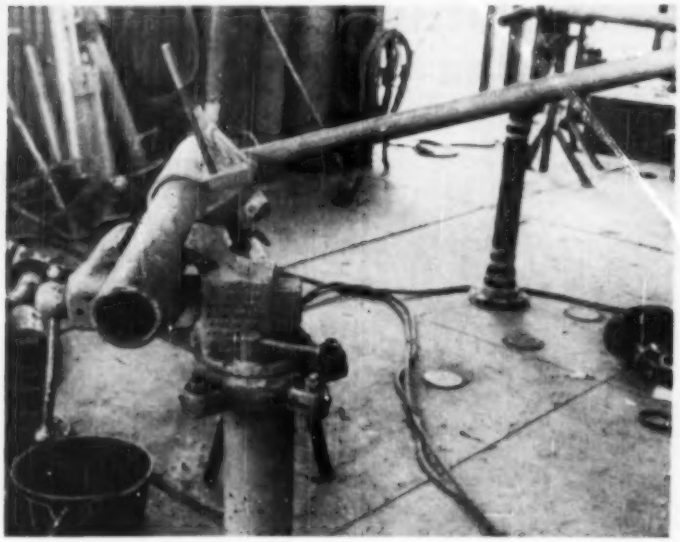
HOW TO—

Build Simple Jigs To Bend U-Bolts

AS U-BOLTS were required in large numbers in a refinery, the welding crew decided that these could be made in quantities in all the sizes needed. After experimenting with various designs of jigs and mandrels, one was built that could be operated by one man with the assistance of a common jaw vice. One jig was made for two-inch U-bolts, similar jigs were made for smaller and larger bolts.

The two-inch unit requires a length of heavy tubing for the handle. A lug welded to one side near the end of the pipe contains a tube through which the bolt is inserted. The bolt passes through a matching hole in the lug. A closely fitting sleeve attached to the handle slips over the end of the pipe with a stop which matches the hole in the mandrel lug and one on a similar lug on the rotating sleeve.

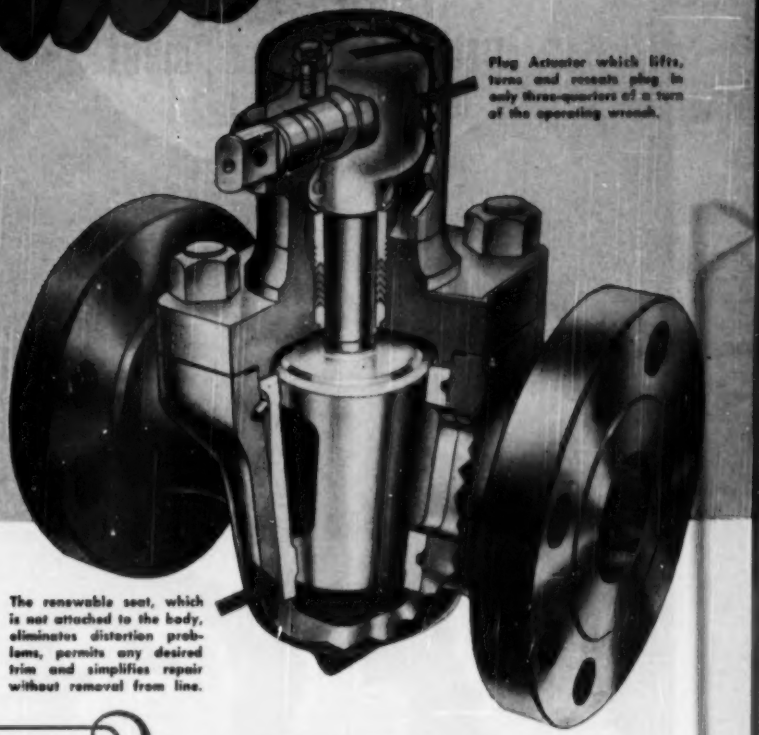
An extension on the sleeve lug stands upright pressing against one side of the straight bolt being formed into a U-bolt. The stock, a straight double end threaded bolt is fitted with a nut and inserted upward through the matching holes. Turning the sleeve with the long handle shapes the U-bolt to the correct turn. A second stop on the opposite side prevents forming a fitting with a greater bend than required for a normal U-bolt.



THE GREATEST VALVE ADVANCEMENT IN YEARS

Cameron

NON-LUBRICATED LIFT-PLUG VALVES



Plug Actuator which lifts, turns and reseats plug in only three-quarters of a turn of the operating wrench.

The renewable seat, which is not attached to the body, eliminates distortion problems, permits any desired trim and simplifies repair without removal from line.

IDEAL FOR

Refinery Service

- GASOLINE DISTILLATE
- HYDROFLUORIC ACID
- SULPHURIC ACID
- DOCTOR SOLUTION
- CHLORINE
- BUTANE
- PROPANE
- LPG
- SALT WATER
- STEAM

AND OTHER CORROSIVE PRODUCTS

NON-LUBRICATED—no grease of any kind required to effect a seal; prevents contamination of line products; and reduces chance for human error and need for maintenance.

PRESSURE SEALING—when plug is seated, line pressure automatically forces seat into tighter engagement with plug—body distortions do not affect the seal.

UNIQUE LIFT-PLUG ACTUATOR — a novel mechanical design which lifts, turns and reseats plug in continuous turn of a lever.

RENEWABLE SEAT AND PLUG—easily replaced; permits any desired trim for specific services.

REPAIRS ON THE JOB—can be completely overhauled without removal from line; no special tools or skill required.

EASY OPERATION—requires less operating effort than other valve designs.

FORGED STEEL—all parts, including body for most sizes, are press or drop forged from specification materials.

Cameron IRON WORKS, INC.

P. O. BOX 1212 HOUSTON, TEXAS

EXPORT: 74 TRINITY PLACE, NEW YORK, N. Y.

Let B&W pour LONGER LIFE into YOUR processing equipment

As vital parts in many types of petroleum processing equipment, B&W Alloy Iron and Steel Castings are demonstrating outstanding ability to resist abrasion, corrosion, and oxidation, and to retain high strength even at elevated temperatures. Operating in just about every kind of tough service, they are helping to keep production up by reducing costly, time-consuming repairs and replacements. Their long-life characteristics have been proved over and over in service temperatures up to 2000 F, and under conditions requiring high creep strength and wear-resistance.

Might pay you, as it has so many others, to call on our broad experience in solving processing problems with heat-resistant and wear-resistant alloy castings from our own modern foundries. The Babcock and Wilcox Co., 85 Liberty St., New York 6, N. Y.

BABCOCK & WILCOX

The MONTH... in the INDUSTRY

Guests inspect Eurotank Refinery at its reopening. (See item at right under picture.)

Executive Order Passed: Brown Becomes PAD Deputy

Bruce K. Brown has been sworn into office by Deputy Petroleum Administrator for Defense. The office is one facilitated by President Truman's order authorizing the hiring of industry officials to hold key staff positions in mobilization agencies without pay from the government.

Brown

Immediately after taking the oath, Brown said that "probably no more than 40 industry men" will be asked to serve with the Petroleum Administration for Defense at the present time. Most of the 40 drafted, he explained, will become regular paid employes.

Interior Secretary Oscar L. Chapman, Petroleum Administrator for Defense, who appointed Brown to the position, described Brown's experience as Assistant Deputy Administrator during World War II and his recent work as chairman of the Military Petroleum Advisory Board.

Brown, who will no longer serve with the MPAB, said that acting chairman will be A. P. Frame of Cities Service Company. Within several months, he said, MPAB committees will be commissioned as part of PAD.

Seeing that the industry obtains the material necessary to provide the liquid fuels for mobilization for civilian consumption is a chief problem facing PAD, Brown said. He said, also, that an octane ceiling on motor gasolines is being considered.

Assistant Deputy of PAD will be Hugh Stewart, chief of Interior's Oil and Gas division, who has been serving as acting Deputy Administrator.

The executive order which made Brown's position possible delegated to Chapman the authority to employ per diem consultants and experts, plus the authority to hire industry men on a full time basis without compensation on certain specified conditions.

The authority was also delegated to the Secretary of Commerce Sawyer for the National Production Authority and to Commissioner Knudsen for the ICC for defense transportation.

Walter S. Hallanan, chairman of National Petroleum Council, said that failure of the oil industry to supply quickly and fully the personnel needs of PAD would be "short-sighted industry policy." Speaking to API board of directors, he urged cooperation with whatever mobilization required.

PAD Praised for Avgas Job

Petroleum Administration for Defense has been commended by the Defense Department, which says it is "well pleased" by the manner in which the Armed Forces aviation gasoline requirements are being supplied.

A summary released by the Armed Services Petroleum Purchasing Agency, meanwhile, showed that although the avgas industry will fall 1,403,000 barrels short of supplying requirements for the last half of 1950, it already has covered the greater portion of avgas requirements for the first half of 1951.

British American Selects Beringer as New Director

Milton S. Beringer has been named to the board of directors of The British American Oil Company, Ltd. Beringer is vice president in charge of manufacturing.

Since joining B-A in 1934 as a refinery superintendent, Beringer has built several major refineries including those at Moose Jaw, Calgary and Clarkson. He directed the recently completed expansion at Montreal East Refinery and, under his direction a new plant is being built at Edmonton and the refinery at Moose Jaw is being expanded.

Beringer has been superintendent of B-A's Turner Valley absorption plant and Calgary refinery. He was appointed manager of refineries in 1945.

AEC Assigns Reactor Project to Phillips

Phillips Petroleum Company has been named by the Idaho operations office of the Atomic Energy Commission as the operator of a new materials testing reactor being built in southeastern Idaho, the appointment being subject to completion of contract negotiations now in progress.

The new multi-million dollar reactor is located on the Snake River plains west of Idaho Falls. It is one of three different types of atomic reactors now being constructed at the Idaho site.

Phillips also is conducting research studies for the Navy on jet fuels, and for the Office of Rubber Reserve in the development and production of synthetic rubbers as well as new types of instruments for control of rubber processing. The company operates the Plains butadiene and synthetic rubber plants in the Texas Panhandle for the Office of Rubber Reserve.

Anglo-Iranian Re-Opens Hamburg "Eurotank" Plant

The reconstructed "Eurotank" refinery at Hamburg, Germany, (see picture top of page) which was acquired by Anglo-Iranian Oil Company in 1948, has been re-opened. Originally built by a German company in 1934, it was virtually destroyed during the war but was restored to limited use in February, 1949. Its rehabilitation, giving a crude capacity of about 4½ million barrels a year, has been completed. In 1940 there were operating a Winkler-Koch combined topping, cracking and reforming plant with an approximate throughput of 2.8 million barrels per year; and a Foster Wheeler atmospheric distillation unit built by Borsig, which was erected for the special purpose of providing close specification products from a wide range of imported crudes.

After Anglo-Iranian took over the refinery in 1948, the rehabilitation program was accelerated. The rebuilt Foster Wheeler unit was put on stream in February, 1949, and plans were completed for modernizing and rebuilding the Winkler-Koch unit, the gas recovery plant and the treating equipment.

The boiler house and other offsite facilities and services were reconstructed, damaged tanks were cut down and rebuilt, and railways were constructed. Utilities distribution systems were extended, and laboratory and general office buildings were erected.

Including Eurotank, Anglo-Iranian has 12 major refineries in Great Britain, Europe, the Middle East and Australia, with a combined refining capacity of approximately 200 million barrels a year.

Gasoline From Coal Made In "Practical" Quantities

Production of gasoline from coal in "practical" quantities for the first time has been disclosed by the U. S. Bureau of Mines.

At the Bureau's demonstration plant at Louisiana, Mo., established to test the possibility of setting up a synthetic oil industry, more than 225,000 gallons have already been produced.

Although production of gasoline has been up to 9000 gallons a month, it is not planned to maintain daily output, since technical appraisal of the process is the chief objective of the tests.

Compared with coal, the nation's oil

The MONTH...

reserves are very limited, according to an Interior Department official. Known available coal is sufficient to last 1000 years even if the nation made all its oil from coal, he said.

However, to free the U. S. from its dependence on oil products, many large plants would have to be built, the official said.

Information Head Named, Program to Be Expanded

John Dupree, representing Socony-Vacuum Oil Company, New York, was elected 1951 chairman of the API Oil Industry Information Committee. Dupree succeeds George H. Freyermuth, manager of the public relations department of Standard Oil Company (New Jersey), the 1950 chairman.

A greatly expanded oil industry information program for 1951 has been approved by the API board of directors, which set up the largest budget in OIIC's history for next year. The program will have a stepped-up advertising campaign through media having total circulation of 47 million.

Vice chairmen of the OIIC are Walter E. Black, Esso Standard Oil Company, Philadelphia; Charles Z. Hardwick, The Ohio Oil Company, Findlay, Ohio; Charles Simons, Texas Mid-Continent Oil and Gas Association, Dallas; and Haines Finnell, Union Oil Company of California, Los Angeles. John Cooke of the API, New York, was elected secretary.

Collection Show Increase In Federal Lube Oil Taxes

A sharp increase was registered in October in federal taxes collected on lubricating oil, from $7,163,260 collected the same month a year ago to $12,638,008 this year. Taxes on transportation of oil by pipe line rose to $1,817,135 from $1,286,669, the Bureau of Internal Revenue reported.

Gasoline tax revenues, however, dropped to $46,924,465 in October, from $49,320,824 a year ago. This tax is levied when product moved from the refinery to storage and may not be indicative of consumer demand, depending upon storage levels at the time of movement.

NPC Gas Committee Urged

Formation of a National Petroleum Council Committee to study natural gas problems and recommend a revised pattern of organization to give natural gas full representation in NPC and PAD has been proposed by Max Ball, former director of the Oil and Gas division of the Department of Interior. Instead of American Gas Association's suggestion to divorce natural gas from PAD and set up a national gas council separate from NPC, Ball urged the creation of a permanent gas committee or panel of NPC, and the expansion and strengthening of PAD to include the gas functions that the Office of War Utilities had during World War II.

Rails Order Diesels Only

Continued dieselization of U. S. railroads has been "the most significant trend in motive-power developments" during the past year, according to Robert M. Coultas, Transportation division, General Electric Company, Schenectady. Speaking before the annual meeting of ASME, Coultas said that in 1950 no new orders for steam locomotives had been placed with domestic builders for use in the U. S.

Emery to Practice Law

Don Emery, a member of the board of directors, member of the executive committee and vice president and general counsel of Phillips Petroleum Company, has resigned as an executive committee member and as vice president and general counsel effective December 31, 1950, to enter the private practice of law in Oklahoma City.

Emery will continue to serve as a director of Phillips Petroleum Company and as a director of American Independent Oil Company.

Rayburn L. Foster, assistant general counsel, was elected vice president and general counsel of Phillips Petroleum Company effective January 1, 1951.

Named to Monsanto Group

Dr. Carroll A. Hochwalt and Felix N. Williams have been appointed to Monsanto Chemical Company's executive committee. This increases the company's executive committee to six men. Other committee members are Dr. Charles Allen Thomas, chairman; Edgar M. Queeny, William M. Rand and R. R. Cole.

Two Appointed to NPC

New members of the National Petroleum Council are Jake L. Hamon of Dallas and A. W. Thompson of Houston. They were appointed to the council because of their elections as presidents of Mid-Continent Oil and Gas Association and American Association of Oilwell Drilling Contractors, respectively.

Burns Heads Up Phillips Perco Program in Mexico

Harry J. Burns has been named senior resident engineer in Mexico for the Perco division of Phillips Petroleum Company and will represent Perco licensing and engineering services in the various refineries of Petroleos Mexicanos.

Burns

Burns, a 1931 graduate of St. Mary's College, St. Marys, Kan., joined the refining department of Phillips in 1932, and progressed to superintendent of manufacturing at the Phillips Kansas City, Kan., refinery. In September, 1945, Burns transferred to Mexico City as Phillips operation supervisor under the Phillips petroleum supervisory contract with the Mexican government.

Ammonia Plant Finished

The Dow Chemical Company's ammonia plant at Freeport, Texas, has been completed and tank-car quantities of anhydrous ammonia are now being shipped. The plant, which has a daily capacity of 100 tons, was under contract to The Austin Company.

Protection Group Formed

A committee on protection of petroleum plant facilities which will prepare a defense program for general industry and government use has been organized by representatives of 12 oil companies meeting in Los Angeles. Elected chairman was J. Howard Myers, The Atlantic Refining Company, Philadelphia. The committee's program objective will be

THE OIL MAN'S CALENDAR

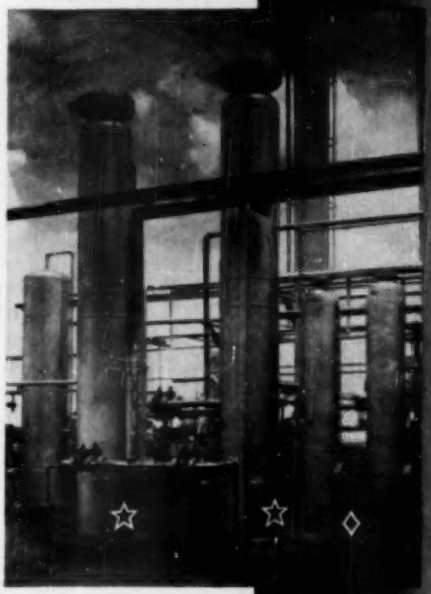
1950	
DEC. 26–31	**American Association for the Advancement of Science, Annual Meeting, Cleveland, Hotel Statler.**
1951	
JAN. 8–12	**Society of Automotive Engineers, Annual Meeting and Engineering Display, Detroit, Hotel Book-Cadillac.**
15–18	**Plant Maintenance Show, Cleveland.**
25–26	**Northwest Petroleum Association, Annual Convention, Minneapolis, Nicollet Hotel.**
26–27	**Instrument Society of America, New York Section, General Meeting "Process Control," New York City, Hotel New Yorker.**
FEB. 27–28	**Wisconsin Petroleum Association, Annual Convention and Equipment Show, Milwaukee, Wisc., Milwaukee Auditorium.**
MAR. 5– 7	**Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy, Pittsburgh, William Penn Hotel.**
5– 9	**American Society for Testing Materials, Spring Meeting and Committee Week, Cincinnati, Ohio.**
12–16	**The Instituto Sudamericano del Petroleo, First Southamerican Oil Congress, Montevideo, Uruguay.**
13–17	**National Association of Corrosion Engineers, Annual Conference and Exhibition, New York, Statler Hotel.**
29–30	**Oklahoma Utilities Association, Convention, Tulsa, Mayo Hotel.**
1951	
APRIL 1– 3	**Western Petroleum Refiners Association, Annual Meeting, San Antonio.**
2– 5	**The American Society of Mechanical Engineers, Spring Meeting, Atlanta.**
10–12	**Southwestern Gas Measurement Short Course, Norman, Okla., University of Oklahoma.**
16–18	**American Society of Lubrication Engineers, Annual Convention and Lubrication Show, Philadelphia, Bellevue-Stratford Hotel.**
18–20	**National Petroleum Association, Cleveland, Ohio, Hotel Cleveland.**
25–27	**Natural Gasoline Association of America, Annual Meeting, Tulsa, Mayo Hotel.**
30 to May 3	**American Petroleum Institute, Division of Refining, Midyear Meeting, Tulsa, Mayo Hotel.**
MAY 6– 9	**Liquefied Petroleum Gas Association, Annual Meeting and Trade Show, Chicago, Stevens Hotel.**
28 to June 6	**Third World Petroleum Congress, The Hague-Scheveningen, Netherlands.**
JUNE 18–22	**American Society for Testing Materials, Annual Meeting, Atlantic City, N. J.**
SEPT. 10–14	**Instrument Society of America, Sixth National Instrument Conference and Exhibit, Houston, Sam Houston Coliseum.**

ALCOA
ACTIVATED* ALUMINA
dehydrates AIR and liquid PROPANE

for the Texas Natural Gasoline Corporation at Wimberly Plant, Tye, Texas

☆ The propane towers shown in the photo dry approximately 30,000 gallons of propane daily to a dew point of *minus* 40° F.

◇ The air drying towers dehydrate approximately 43,000 cu. ft. of air per day to a dew point of *minus* 20° F.



Operated since October, 1948, these two units show the day-in-day-out dependability of ALCOA *Activated* Alumina—a desiccant that can be reactivated an almost unlimited number of times without appreciable effect on its moisture adsorption efficiency. Alumina particles are strong . . . do not break down on repeated cycles of saturation and reactivation. Neither liquid water nor wet steam causes disintegration.

ALCOA *Activated* Alumina not only dries liquids and air but also dehydrates gaseous hydrocarbons to lower dew points than any other commercial adsorbent.

If you want to take advantage of the economies ALCOA *Activated* Alumina offers as a drying agent, write to: ALUMINUM COMPANY OF AMERICA, CHEMICALS DIVISION, 617M Gulf Bldg., Pittsburgh 19, Pa.

*Reg. T.M., *Aluminum Co. of America*

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ACTIVATED ALUMINAS • CALCINED ALUMINAS • HYDRATED ALUMINAS • TABULAR ALUMINAS • LOW SODA ALUMINAS ALUMINUM FLUORIDE • SODIUM FLUORIDE • SODIUM ACID FLUORIDE • FLUOBORIC ACID • CRYOLITE • GALLIUM

FIRE PREVENTION

plus INSURANCE SAVINGS

Savings in insurance premiums of $6,000.00 per month, and reduction of 500 different policies to three, were obtained by one extraction processor, due to the elimination of fire and explosion hazards in his three plants, essentially aided by R-C Inert Gas Generators.

Admitting that this instance is exceptional because of the size of the plants, the amount of insurance, and other factors, nevertheless it is apparent that both large and small companies may make important savings in insurance costs, and provide improved protection against business interruption and property damage, where explosion and fire hazards must exist in their processing.

Through the use of inert gas, economically generated by R-C units, hazardous plant locations can be made safer against explosion and fire, thus proving again that "an ounce of prevention is worth a pound of cure". Portable units are readily movable from one plant to another, or stationary units can be installed where such hazardous conditions must be continuously contended with.

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BLOWER BUILDERS SINCE 1854
ONE OF THE DRESSER INDUSTRIES

The MONTH...

based upon PAW's "Guide to Wartime Protection of Petroleum Facilities," used during World War II.

Socony-Vacuum Process Will Raise Octane Rating

A new catalytic reforming process to improve the octane rating of gasoline was announced at an annual meeting of top manufacturing and technical personnel of the Socony-Vacuum Oil Company, Inc., in Los Angeles.

Speakers reported on several years of research and development work on the new process, including data from a semi-commercial unit operating since spring at a rate of 50 barrels per day. Socony-Vacuum engineers are designing a commercial-size unit.

Company officials said technical and engineering details of the new catalytic reforming process will be announced shortly.

Chemistry Society Elects Petroleum Division Leader

Dr. Bernard H. Shoemaker of Whiting, Ind., divisional director of research of Standard Oil Company (Indiana), has been elected chairman of the American Chemical Society's Division of Petroleum Chemistry. Dr. Shoemaker succeeds Dr. A. A. O'Kelly, technical director of the Alox Corporation, Niagara Falls, N. Y.

Dr. F. E. Frey, assistant director of research of Phillips Petroleum Company, Bartlesville, Okla., was named chairman-elect, and Dr. C. G. Kirkbride, vice president of the Houdry Process Corporaton, Marcus Hook, Pa., was re-elected secretary-treasurer.

ILO Petroleum Committee Adopts Welfare Program

Better housing, health protection and education facilities for the world's oil refining and production workers were included in the program adopted by the International Labor Organization's Petroleum Committee.

Employer, worker and government delegates from 14 major petroleum producing or refining countries took part in drafting a series of resolutions and reports which form the basis of the program.

Refining Dividends Up

Publicly-reported cash dividends of oil refining industry totaled $141.5 million during September, compared with $83.9 million for the same month a year ago, the Department of Commerce reported. The statement added that third quarter earnings for 1950 rose to $171.7 million from $132.5 million for the comparable 1949 period.

Says Antitrust Laws Vague

In an article, "'Bigness' Isn't Badness," Oscar John Dorwin, general counsel of The Texas Company, declares that a "non-partisan, non-political" group should be organized to study the antitrust laws in the light of present day conditions and restate their purposes and provisions.

Dorwin says that the crux of the Justice Department's divorcement suit

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The MONTH...

against seven West Coast oil companies is, as he sees it, in the present indefiniteness of the antitrust laws and the uncertain social and economic purposes which they are being used to serve.

The article appears in the company's publication for stockholders and employes.

Watts Named ASME Fellow

George W. Watts, director of engineering for the manufacturing department of Standard Oil Company (Indiana), has been elected a fellow of the American Society of Mechanical Engineers for "acknowledged engineering attainments." Watts joined Standard in 1915 as a draftsman at its Whiting, Ind., refinery and in 1928 became chief engineer for the manufacturing department. He was instrumental in the formation of the engineering research department in 1945.

Watts

During World War II Watts was on leave of absence to direct for Kellex corporation the design, construction, procurement, and erection of pumping equipment and process instrumentation for the Oak Ridge, Tenn., uranium diffusion plant.

Research Club Organized At Texaco's Beacon Lab

The Texaco Research Club, affiliated with the Scientific Research Society of America, has been organized at the Beacon Laboratories of The Texas Company at Beacon, N. Y. Formed by 51 technical employes, the club is the seventh such organization to affiliate with the Scientific Research Society of America (RESA), the industrial counterpart of Sigma Xi.

Harry M. Allred is president of the group. Other officers are J. Paul Ferrin, vice president; Fred W. Moore, treasurer, and Kurt H. Strauss, secretary.

Sells Houdry Interest

Socony-Vacuum Oil Company ended all connection with Houdry Process Corporation, Philadelphia, by selling its stock in the catalytic refining licensing company. It was disclosed that Sun Oil Company purchased part of the stock, but less than a 50 percent interest.

Predicts Nationalization

A prediction that the oil industry will be nationalized by 1980 "unless something is done" was made by Dr. Arthur A. Smith, vice president of the First National Bank of Dallas. Speaking at a meeting of Mid-Continent Oil & Gas Association division members, he said that there is little doubt that the great

Accounts of the API Sessions, Page 201. CNGA Meeting Report, Page 204.

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basic industries of the U. S. are marked for nationalization.

Sunray Fluid Cat Cracker Sets a New World Record

The world's record for continuous operation of a Fluid catalytic gasoline cracking unit was broken at 11 a.m. November 8 when Sunray Oil Corporation's 25,000-barrel-daily capacity unit at Sunray Village, near Duncan, Okla., passed the 611-day mark. The former continuous operation record was 610½ days set at the Tide Water Associated Oil Company's Avon, Calif., refinery in 1948.

The Sunray refinery unit at Duncan will continue to run without shutdown as long as its present high rate of efficiency is maintained, Floyd L. Martin, Sunray's refinery division vice president, said. On the morning of December 4 the run was continuing, Martin at his office in Tulsa, said.

"It is a great compliment to our refinery personnel and the men in all departments who have taken every precaution to assure this long efficient operation," Martin declared.

The "cat," designed by UOP, is operated under the direct supervision of R. L. (Dick) Johnson, refinery manager, and Aultman T. Smith, assistant plant superintendent, in charge of the unit's physical operations.

Head operators responsible for the four shifts are R. H. Coates, C. W. Dean, Buster Ludwick, and Paul Haggard.

Since the record run was started in March, 1949, about 6,110,000 barrels of raw charge has been processed to the unit at an average daily charge rate of approximately 10,000 barrels. The on-stream efficiency of the Duncan refinery has been calculated at 99.7 percent.

Ogarrio Resigns Post

R. Ogarrio has resigned as vice president and director of The Texas Company, and will retire December 31. He will have completed 34 years' service with the company, an association which began in 1916 in the company's operations in Mexico.

Ogarrio will establish residence in Mexico and will continue in a consulting and advisory capacity primarily on the company's foreign activities.

Koppers Position Given Foy

J. N. Forker, vice president and general manager of the Tar Products division, Koppers Company, Inc., since 1946, has retired and has been succeeded by Fred C. Foy, who formerly headed the Koppers sales department.

Cooke Bausman, Jr., who was assistant to Foy, has been named acting manager of the sales department.

Research Leader Named

F. Warren Bickel, technical director of the Diamond Wire and Cable Company, has been named project leader in a new rubber research laboratory at Armour Research Foundation of Illinois Institute of Technology.

Bickel, who will direct compounding operations and evaluation work with the

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TYPE "NU"—all steel welded construction, gear motor drive. No cast parts—three bearing supports to Mixer shaft (two ball bearings and one single lantern bearing). Suitable for all installations not requiring a double lantern box—less original cost—all standard sizes from ½ to 30 horsepower.
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Defense Critical Job List Adds Stillmen and Treaters

The Department of Labor has added to its list of "critical occupations" that of stillmen and treaters in the petroleum processing field.

Prepared as a guide to the Defense Department in expanding the Armed Forces, the list along with one by the Department of Commerce on "Essential Activities" is being reviewed by a joint committee which is expected to recommend for revisions to the "Essential Activities" list.

Resumes Normal Operations

Damage caused by a mid-November fire and seven explosions at Gulf Oil Corporation's Port Arthur refinery interrupted operations only temporarily, and the plant would suffer no reduction in its "over-all annual thruput," a company announcement said. Principal damage in the $500,000 blaze was to the distillation and storage facilities.

Bennett General Auditor

Standard Oil Company of California has announced the appointment of L. E. Bennett as general auditor, succeeding A. H. Kent, who retired on November 30 after 33 years of service with the company.

Bennett, who joined Standard at Los Angeles in 1920, has been assistant general auditor since May, 1944.

Extends Antitrust Suit Time

Federal Judge James Carter has extended the deadline for filing objections and answers to the Department of Justice's antitrust suit against seven West Coast major oil companies. The date, originally set as October 7, will be February 6, 1951. The extension is the second one granted.

ISA CONVENTION COMMITTEE ORGANIZES—The Houston section committee of the Instrument Society of America recently met and discussed plans for the sixth national instrument conference and exhibit to be held in the Sam Houston Coliseum, September 10-14, 1951. The following, shown in the picture, were present: Seated, left to right, Dale Mattix, Cities Service Corporation, Lake Charles, La.; C. R. Miller, General Tire and Rubber Company, Baytown, Texas; M. J. O'Neal, Shell Oil Company, Houston (president, Gulf Coast Spectroscopic Group); C. W. Bates, Humble Oil & Refining Company, Baytown, Texas; Prof. G. L. Farrar, department of chemical engineering, A. & M. College of Texas (chairman of steering committee for Symposium on Instrumentation for Process Industries); M. K. Anderson, Carbide and Carbon Chemical Company, Texas City, Texas; W. H. Fortney, Humble Oil & Refining Company, Baytown (chairman, Houston ISA 1951 convention committee); Paul H. Buehner, convention manager, Houston Chamber of Commerce. Standing: W. B. Rawson, vice president, Maintenance Engineering Corporation, Houston; A. Costa, Westcott & Greis, Houston; R. E. Hanson, Leeds & Northrup Company, Houston; E. E. Kleir, The Foxboro Company, Houston; R. L. Nichols, Magnolia Petroleum Company, Beaumont, Texas; C. L. Garner, Garner Instrument Company, San Antonio; L. C. Books, Shell Oil Company, Houston; I. K. Farley, Brown Instrument Division, Houston; Richard Rimbach, executive secretary, ISA, Pittsburgh, Pa.

Sohio's Board Chairman Dies

Wallace Trevor Holliday, 66, chairman of the board of The Standard Oil Company (Ohio), died November 7 in Cleveland. An attorney, Holliday was attorney for various oil producing, pipe line, refining, and marketing companies as a member of the firm of Holliday, Grossman and McAfee. In 1917, while continuing his private practice, he became general counsel for Sohio. He left his law firm in 1928 to accept the post of president of Standard of Ohio. He remained in that office until April, 1949, when he became chairman of the board.

Holliday was active in numerous oil associations, including API, the National Petroleum Council, and the National Petroleum Association. He had been a member of the PIWC, and was a director of the NAM. In recent years, he was active in the United World Federalists, Inc., and as vice president he championed the movement for world peace through world government.

C. B. Watson Dies at 63

Cornelius Bushnell Watson, 63, a director and formerly vice president in charge of marketing, refining and transportation of The Pure Oil Company, died November 2 at Chestertown, Md. A graduate of Yale's Sheffield Scientific School, Watson joined Pure in 1916, after working eight years for his father's oil companies. He retired in 1947.

Refining Executive Dies

Temple W. Tutwiler, 71, a director, member of the executive committee and chief engineer of Cities Service Company, died November 9 in Birmingham. During World War II he was given the job of expediting construction of the Lake Charles, La., refinery named in his honor.

Supply Firm Official Dies

August R. Maier, 49, director of engineering of the Oil Well Supply Company, died October 27 in Dallas. Maier had been with the company since 1930.

Technician to Lab Staff

Dr. Robert B. Killingsworth, assistant director, Technical Service Department, Brooklyn, has been transferred to the headquarters staff of Socony-Vacuum Laboratories, a division of the Socony-Vacuum Oil Company, Inc.

Diwoky Acting President

With the appointment of Bruce K. Brown, president of Pan-Am Southern Corporation, New Orleans, as deputy

Trends of Operations and Changes in Stocks

Figures on crude stocks are from Bureau of Mines weekly reports; all others from American Petroleum Institute weekly reports, which are estimates on Bureau of Mines basis.

(All figures in thousands of barrels—add 000)

Trends in Week Ended	Crude Oil			Gasoline		Gasoil and Distillate		Residual Fuel	
	Production Daily	Runs to Stills Daily	Stocks Week End	Production Weekly	Stocks Week End	Production Weekly	Stocks Week End	Production Weekly	Stocks Week End
1949:									
January 29	5,493	5,400	255,458	17,531	114,677	7,547	62,142	8,178	63,333
February 26	5,401	5,412	261,965	17,021	124,762	7,450	54,008	8,228	56,348
March 26	5,188	5,353	266,506	17,417	128,047	6,167	48,721	8,305	58,792
April 30	4,980	5,273	271,255	17,980	124,787	6,681	49,950	8,185	60,174
May 28	4,951	5,297	275,190	18,376	120,661	5,943	55,971	8,144	63,758
June 25	4,944	5,322	274,114	18 452	115,715	5,148	63,049	7,856	66,146
July 30	4,731	5,167	271,999	18,058	109,964	6,293	70,767	7,205	67,166
August 27	4,799	5,215	266,455	18,180	106,280	6,491	74,716	7,597	66,394
September 24	4,933	5,377	259,180	18,152	103,262	6,556	81,414	7,419	68,143
October 29	5,075	5,509	252,069	19,002	103,915	7,016	90,358	7,754	69,459
November 26	5,192	5,331	256,409	18,204	104,917	6,971	91,795	8,104	67,087
December 24	4,955	5,482	256,830	18,045	110,184	7,335	78,662	8,046	61,647
1950:									
January 28	4,956	5,470	248,411	18,363	124,970	7,302	66,337	8,389	57,036
February 25	5,000	5,277	245,586	17,703	133,888	6,890	56,050	7,855	48,663
March 25	4,848	5,409	244,227	17,839	138,406	6,870	40,577	8,171	42,546
April 29	5,014	5,314	244,744	18,038	128,585	6,531	36,686	7,272	39,260
May 27	5,118	5,501	240,842	18,704	122,757	7,201	40,607	7,421	39,308
June 24	5,355	5,636	240,762	19,626	115,036	6,868	50,580	7,461	41,291
July 29	5,522	5,870	240,236	19,981	109,076	7,266	61,437	7,870	42,253
August 26	5,699	6,197	236,974	20,263	105,793	7,559	65,841	8,543	41,697
September 30	5,903	6,051	241,631	19,624	104,383	8,460	76,734	8,306	42,330
October 28	5,895	6,051	244,806	19,478	105,062	8,256	84,057	8,449	44,310
November 25	5,888	6,238	244,497	19,847	106,424	8,591	86,768	8,470	45,566

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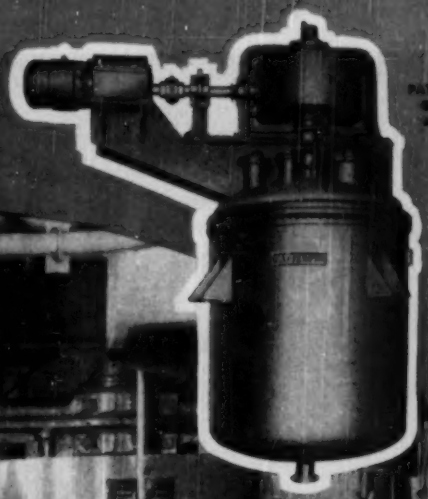
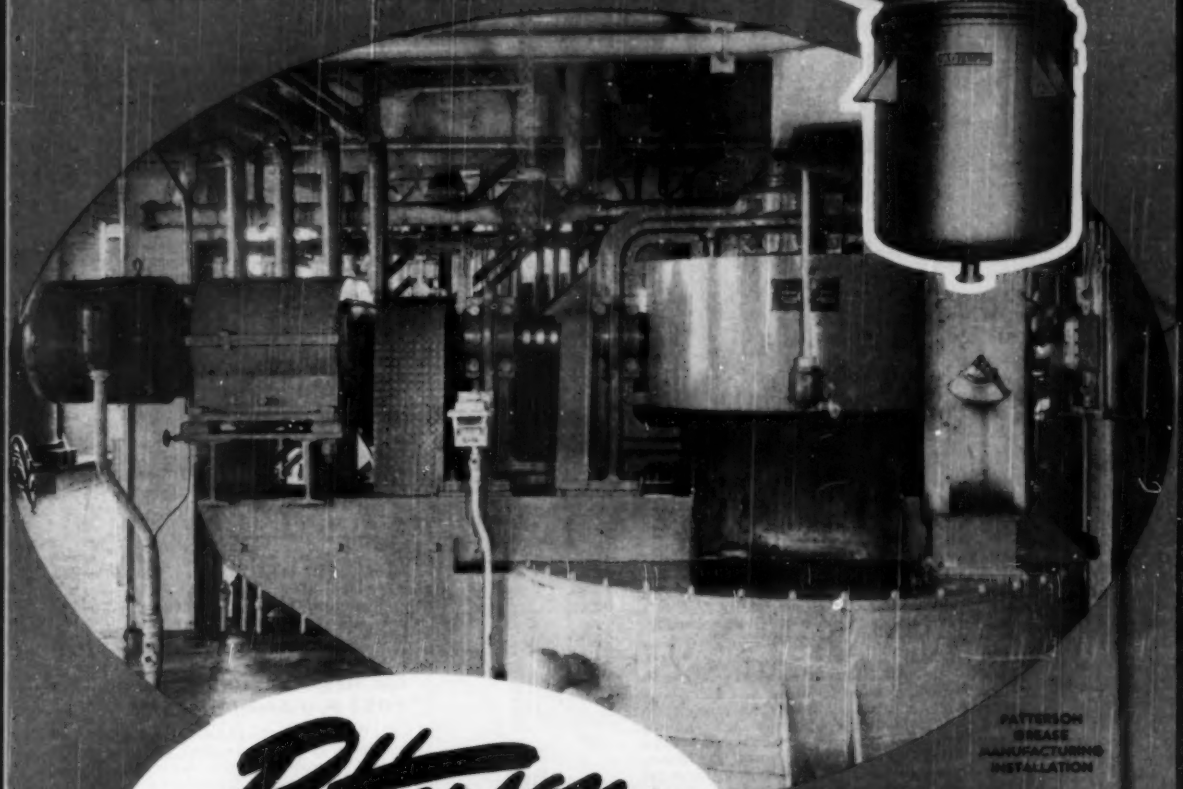


PATTERSON GREASE KETTLE



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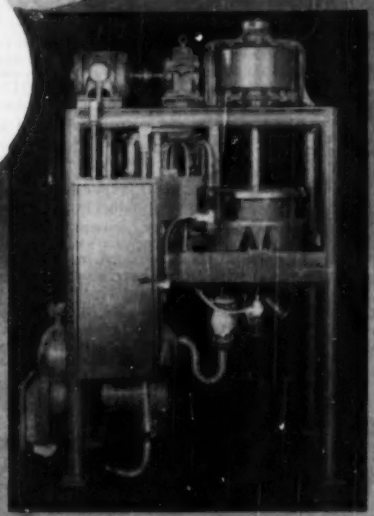

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Be sure you get *only* genuine RUST-OLEUM for positive protection against rust! Specify *RUST-OLEUM* to your contractor or architect on any new construction, remodeling or maintenance work.

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The MONTH...

administrator of the Petroleum Administration for Defense in Washington, Roy J. Diwoky, executive vice president, will take over the duties as president of Pan Am during Brown's absence.

Brown is expected to be in Washington for at least a year, serving under Secretary Oscar L. Chapman.

Diwoky, formerly of Standard Oil Company (Indiana), was appointed executive assistant to President Brown in June, 1949, and was recently made executive vice president.

New Cat Cracking Units Raise Yield Efficiency

Catalytic refining of petroleum to yield high-grade gasoline is at a higher point of efficiency than ever before as the result of new developments in the process by Socony-Vacuum Oil Company, Inc., according to the current issue of *The Flying Red Horse*.

Until the new type unit was introduced recently by Socony-Vacuum the catalyst in the form of beads was raised by bucket elevators after regeneration of the catalyst to remove carbon which it accumulated during the "cracking" process. Now the catalyst is raised by compressed air to a height of 200 feet to the top of each unit.

Eight of the new "gas-lift" units are being built in Socony-Vacuum refineries to replace previous types which used fixed beds of catalyst. Their combined capacity will be 40,000 barrels more per day than their predecessors. Four are being built under licenses to other American oil companies. Two are being erected also in Socony-Vacuum refineries abroad and three more have been licensed to other European refiners.

Los Angeles Engineer Is 1951 President of ASME

J. Calvin Brown, engineer and patent attorney of Los Angeles, has been named president of the American Society of Mechanical Engineers for 1951. Brown succeeds James D. Cunningham of Chicago.

Regional vice presidents elected are Henry Reginald Kessler, manager, Republic Flow Meters Company, New York; Stephen Dewey Moxley, vice president, American Cast Iron Pipe Company, Birmingham; Dr. John T. Rettaliata, dean of engineering, Illinois Institute of Technology, Chicago; and Carl J. Eckhardt, professor of mechanical engineering and superintendent of utilities, University of Texas, Austin.

Directors-at-large are Lionel J. Cucullu, assistant to chief engineer, New Orleans Public Service, Inc., New Orleans, and Harold E. Martin, district manager, The Babcock & Wilcox Company, New York.

Gulf Promotes Kuhne

P. K. Kuhne, assistant to the general manager, manufacturing department, Gulf Oil Corporation, has been given the added assignment of assisting in the administration of the technical division of the manufacturing department. He joined Gulf as an assistant chemist in the Port Arthur refinery in 1927 and subsequently became chief chemist,

The MONTH...

Philadelphia refinery, in 1930, and supervisor of the refinery technology division there in 1934.

Kuhne was transferred to Pittsburgh as assistant to the general manager, manufacturing department, in 1941 and will continue to be located there.

New Ethyl Division Will Integrate Technical Data

Establishment of an information division to integrate technical information activities at the Ethyl Corporation research laboratories in Detroit was announced by Earl Bartholomew, general manager of the research laboratories.

Weil

B. H. Weil, formerly head of the technical information division, State Engineering Experiment Station, Georgia Institute of Technology, has been named supervisor of the new division. Bernard A. Jones, formerly head of the Ethyl laboratories' technical data section, has been named operations manager, and Charles B. Kass and Donald MacDonald have been assigned as engineer-writers to the information division's staff.

The collection, cataloging, and reporting of technical material will be among the responsibilities of the information division.

Yant Heads Safety Group

Dr. William P. Yant, director of research and development for Mine Safety Appliances Company, Pittsburgh, has been elected president for 1950-1951 of the American Society of Safety Engineers. Yant, who has been with the company since 1936, formerly was supervising engineer of the Pittsburgh Experiment Station, U. S. Bureau of Mines.

Two New Executives Added

Catalytic Construction Company has elected John A. Schumacher comptroller, and F. W. Adams assistant treasurer.

Schumacher succeeds W. Graham Jamison, who had previously been elected vice president and treasurer. Adams succeeds Schumacher as assistant treasurer, and continues as manager of the Field Accounting division.

National Grease Institute Elects Cooper President

Howard Cooper, manager of technical service for Sinclair Refining Company, has been elected president of the National Lubricating Grease Institute. He succeeds A. J. Daniel.

Cooper joined The Texas Company as lubrication engineer following his graduation from the Armour Institute of Technology. He became associated with Sinclair Refining in 1923.

NLGI vice president is G. E. Merkle, vice president of Fiske Brothers Refining Company, Newark, N. J. C. B.

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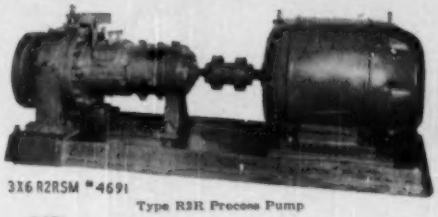
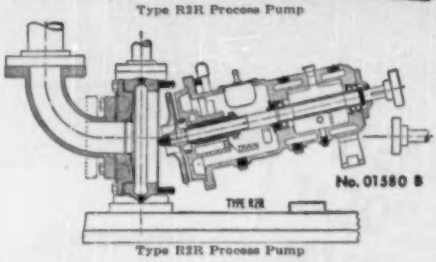
Type R2R Centrifugal Process Pumps



Type R2R Process Pump



Type R2R Process Pump

DISASSEMBLY: The Type R2R process pumps can be disassembled without disconecting the suction and discharge piping. By first removing the spacer from the spacer type coupling, and unbolting the casing from the cradle the entire cradle and complete rotating element can be removed without disturbing the suction and discharge piping.

OPERATING RANGE: Type R2R, Heavy duty, process pumps are available in eighteen different sizes, enabling our engineers to furnish units specially designed and constructed for the particular work to be performed.
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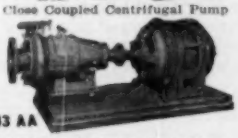
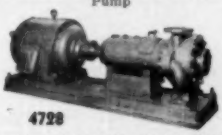
Close Coupled Centrifugal Pump

3510
Horizontal, Single Style, Double Acting, Piston Type, Close Clearance Pump. Designed to handle volatile liquids



4043 AA
Pedestal Mounted Centrifugal Pump

3833
Horizontal, Duplex, Double Acting, Side Pot, Piston Type, Oil Bath Power Pump



4728
Double Pedestal Bearing Centrifugal Pump

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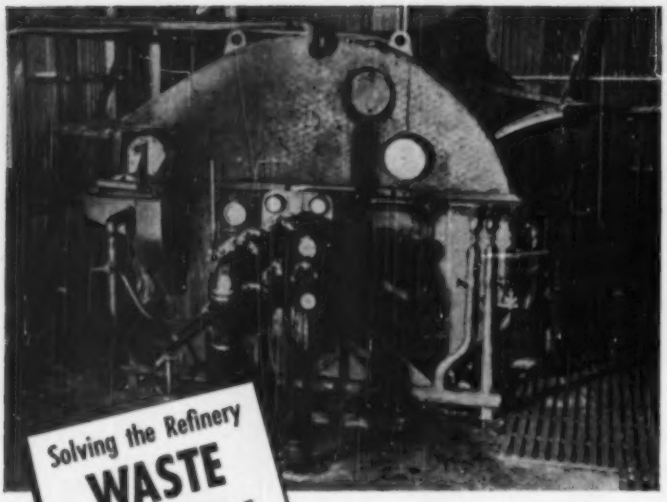

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Trap residues—separator box emulsions—sludges . . . the Oliver Precoat Filter can effectively handle these wastes by dewatering sludges and breaking oil-water emulsions, resulting in stocks for refinery re-run and water ready for disposal in public streams. For example, a refinery is obtaining an oil phase carrying only 2/10 of 1% sludge and only a trace of water; the water phase is comparatively oil-free.

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The MONTH...

Karns, Esso Standard Oil Company, Pittsburgh, was re-elected treasurer.

LPGA Safe Practies Code Reproductions Available

Reproductions of the Code of Safe Practices adopted by the Liquefied Petroleum Gas Association which can be signed, framed and displayed in their places of business have been mailed to complying industry companies.

Drafted by LPGA's safety committee, under the leadership of H. Emerson Thomas, H. Emerson Thomas & Associates, Westfield, N. J., the code covers all phases of the industry's responsobilities to customers, the public, the community and the nation.

Construction Notes

More building items on Page 74

Braun Will Build Addition To Texas Chemical Plant

Jefferson Chemical Company, Inc., will begin manufacturing monoethanolamine, diethanolamine and triethanolamine next year at its Port Neches, Texas, plant. A contract has been awarded to C. F. Braun & Company for erection of a unit for the ethanolamines, and completion is scheduled for the latter half of 1951.

One of the raw materials Jefferson will use in manufacturing the ethanolamines is ethylene oxide, which it has been producing at Port Neches since 1948. In addition to ethylene oxide, Jefferson makes ethylene glycol, diethylene glycol, ethylene dichloride, and related products.

Suez Refinery to Expand

An expansion program that will increase production of its Suez refinery by about 7½ million barrels per year is being planned by the Egyptian government, which has set aside $2.324 million to purchase additional equipment for the project. The present government-owned refinery is producing 2½ million barrels annually.

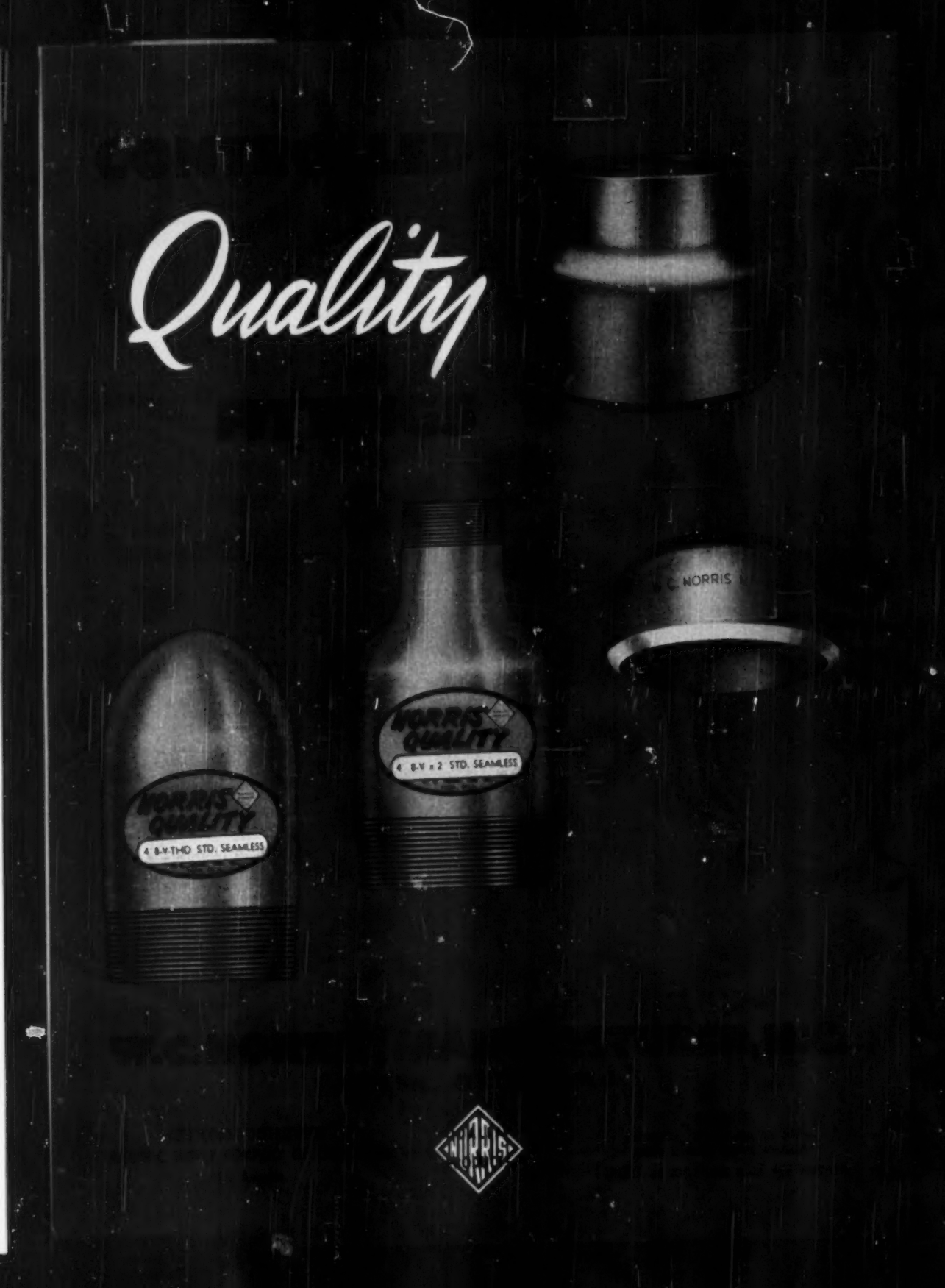
Complete Montevideo Units

Administracion Nacional de Combustibles Alcohol y Portland has completed and now has in operation an atmospheric unit and a vacuum plant for lubes and asphalts at its refinery in Montevideo, Uruguay. Engineered by Foster-Wheeler Corporation, the new units will bring production at the refinery up to 7500 barrels daily.

Winnipeg Plant Under Way Despite Adverse Weather

Despite disastrous early spring floods, work is well under way at the new 12,000-barrel-per-day refinery for Imperial Oil Limited at Winnipeg, Manitoba, it was announced by the contractor, Canadian Kellogg, Ltd., subsidiary of The M. W. Kellogg Company.

Construction under way includes a fluid catalytic cracking unit, an atmospheric and vacuum pipestill, a treating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The MONTH...

plant for gasoline and middle distillates, an electric substation, auxiliary buildings, and off-site facilities.

The new refinery will more than triple the current refining capacity of Manitoba.

Pemex Salamanca Refinery Begins Full Operations

The new 30,000-barrel-per-day Petroleos Mexicanos refinery at Salamanca, Guanajupato (150 miles northwest of Mexico, D. F.), has begun full operations. Engineering and construction were handled by Arthur G. McKee & Company, Cleveland.

Desulfurization of the straight run gasoline production will be performed in the 11,600-barrel-per-day Perco cycloversion unit.

Programs to modernize and expand the facilities of the Petroleos Mexicanos refineries at Tampico, Tamaulipas, and Atzcapotzalco, D. F., are also under way. These refineries will incorporate 12,000-barrel-per-day Perco cycloversion units.

Lummus to Build Taylor Unit

The Lummus Company has completed engineering of 8000-barrel-daily catalyst cracking unit which they have contracted to build for Taylor Refining Company at its Corpus Christi refinery. The unit, which is licensed by Socony-Vacuum Oil Company, Inc., is scheduled for completion in July, 1951.

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North American to Build Plant in Italy for AGIP

Azienda Generale Italina Petroli has signed a contract with North American Petroleum Gas Corporation of New York for a gasoline extraction plant to be erected in the Cortemaggiore field of northern Italy. The plant, which will process 100 million cubic feet of gas daily, is expected to be the largest plant of its kind in Europe. It will produce gasoline, other distillates, propane and butane.

The contract with North American Petroleum Gas Corporation was signed after a visit to the U. S. of a group of Italian technical experts representing AGIP.

Engineering for the plant and its equipment will be by J. F. Pritchard & Company of Kansas City.

Uranium Plant Is Awarded To Catalytic Construction

Catalytic Construction Company, Philadelphia, has been awarded a contract for design and engineering of a uranium ore refinery at an undetermined location for the Atomic Energy Commission. Work under the contract will be accomplished in two phases: a study of existing research and development work on uranium refining processes and preliminary engineering; and final selection of a process and detailed design and engineering. Cost of the plant will be approximately $10 million.

Houston Butadiene Plant Reactivated by Sinclair

First of the nation's standby petroleum butadiene plants to be reactivated under the extended rubber program of the Office of Rubber Reserve, RFC, has started production at Houston. Sinclair Rubber, Inc., operates the plant.

When operating at proven capacity, the annual production of butadiene will be approximately 75,000 tons, which will be delivered to the adjacent copolymer plant operated by Goodyear Synthetic Rubber Corporation.

Officials at the plant are J. O'C. Brown, manager; C. W. Hardell, superintendent; and R. C. Woerner, assistant superintendent.

Big Sandy Plant Modernized

The Big Sandy, Texas, refinery of R. Lacy, Inc., has completed its modernization and expansion construction program. The 1300-barrel-per-day Perco cycloversion unit was designed to desulfurize cracked stocks or reform straight run, dependent upon the product specification requirements. Other new units include a gas stabilizer and polymerization unit.

Engineering for the project was performed by The Ralph M. Parsons Company, Los Angeles. C. A. Turner Construction Company, Houston, handled the construction.

To Expand Trinidad Refinery

An addition to its Trinidad refinery is being designed for Trinidad Leaseholds, Ltd. Head Wrightson Processes, Ltd., London, is engineering the project which has an estimated cost of $300,000.

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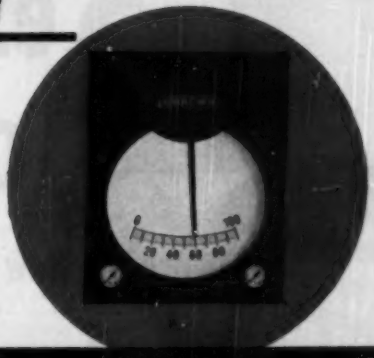

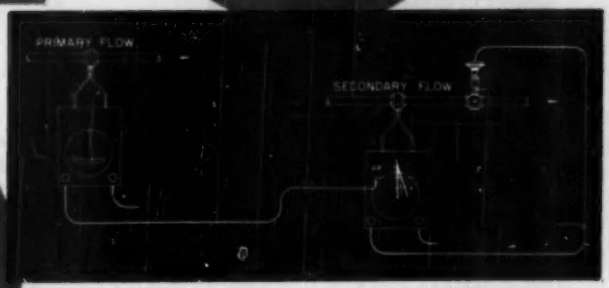

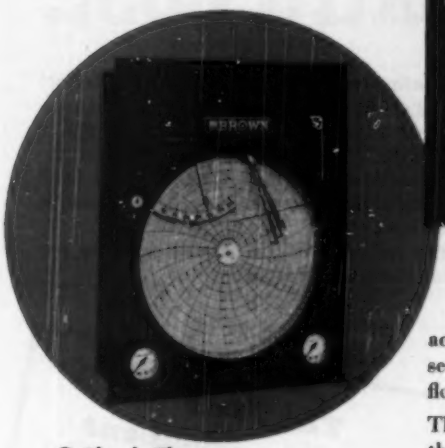

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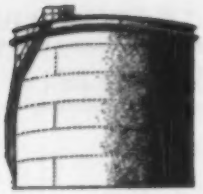

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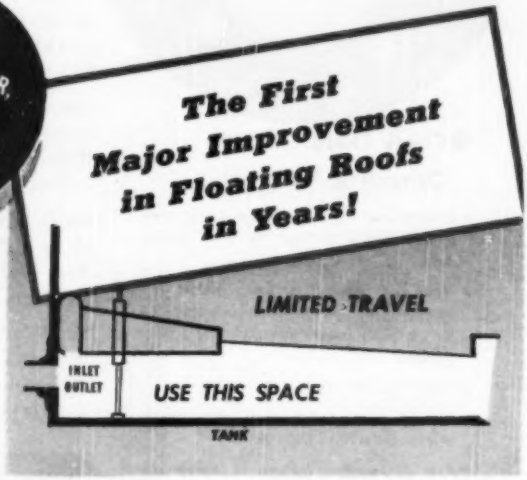

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SCIENCE and TECHNOLOGY Abstracts

Prepared by
DR. E. H. LESLIE and DR. H. B. COATS
The Leslie Laboratories
Traver Road, Ann Arbor, Mich.

Manufacture: Processes and Plant

Heat Transfer, Mass Transfer, and Fluid Friction Relationships in Turbulent Flow. THOMAS K. SHERWOOD. *Ind. Eng. Chem.*, **42** (1950), pp. 2077-84.

The purpose of the paper is to outline the basic similarities of the three transfer processes, heat transfer, mass transfer, and fluid friction, and to set forth the relationships connecting them. Since the subject is broad and complicated and can be covered only in general outline, the discussion of the paper is limited to transfer between a pipe wall and a fluid passing turbulent flow through the pipe. The nature of the flow of fluids in pipes and the concepts of molecular diffusion, turbulence, and eddy diffusion are reviewed, and the theories of the over-all process of transfer from a pipe wall to a turbulent fluid stream are summarized. Representative data covering the three processes are compared to illustrate their basic similarity and the simplicity of the relationships between them.

Heat Transfer and Pressure Drop in Annuli, Measurements on Plain and Transverse Fin Tubes Using Water. JAMES G. KNUDSEN AND DONALD L. KATZ. *Chem. Eng. Progress*, **46** (1950), pp. 490-500.

The literature covering the pressure drop in annuli with smooth tubes, pressure drop in annuli containing fin tubes, heat transfer in annuli containing smooth tubes, and heat transfer in annuli containing fin tubes is briefly reviewed. However, no general correlation has been given for heat transfer from fin tubes that considers the effect of tube dimension, such as fin height and fin spacing. The authors studied one plain and six fin tubes, 9 feet long. These were tested in the range of Reynolds numbers from 1000 to 70,000 in the annulus. The mechanism of the flow of water between the fins was observed. Photographs are included showing the flow pattern. A correlation is given for heat transfer which includes factors to account for fin height and fin spacing. Performance of the tubes was compared on two bases, (1) the power performance, which is the power required for the transfer of a unit of heat, the volume performance, which is the amount of heat transferred/unit of volume occupied by the exchanger. Fin tubes were superior to smooth tubes in volume performance. Some fin tubes were better than plain tubes in power performance and some were poorer.

Condensation on Vertical Finned Tubes. ALLAN V. FORBES AND K. O. BEATTY, JR. *Chem. Eng. Progress*, **46** (1950), pp. 531-6.

The heat-transfer coefficients in the condensation of methanol and trichlorethylene were measured using ⅝-inch diameter tubes with 1/16-inch high spiral fins, and also ¾-inch plain tubes in a vertical position. Tube lengths studied were 18-inch, 36-inch and 48-inch, and temperature differences of from 30 to 118° F. were used. The results showed that the effects of fluid properties, tube length, and temperature difference were the same for the finned tubes as for the plain tubes. Therefore a Nusselt-type equation can be used for finned tubes with a coefficient of 0.725 instead of 1.10 as recommended for plain tubes. The reduction in coefficient per square foot of surface is more than offset by the increased area. The result is that the over-all coefficient for finned tubes are about 50 percent higher than for plain tubes. The authors conclude that finned tubes can be used in vertical tube condensers with advantage as to economy in size of unit, or alternatively to get a gain in capacity.

Batch Fractional Distillation. Calculated and Experimental Curves for Batch Distillation with Appreciable Holdup. ARTHUR ROSE, R. CURTIS JOHNSON, AND THEODORE J. WILLIAMS. *Ind. Eng. Chem.*, **42** (1950), pp. 2145-9.

The course of a batch distillation is shown best by curves showing the change of distillate composition as a function of percent distilled. Distillation curves showing the change of composition with percent distilled were calculated by a step-by-step procedure. A corresponding series of experimentally determined distillation curves are also given. The similarity of groups of experimental and calculated curves is evident. Examples are given of the effect of holdup and of the composition of the charge. The authors feel that the results justify efforts to make rather laborious calculations and to extend the range and degree of correspondence of experimental and calculated curves so as to be able to predict the effect of holdup for batch distillations that are of practical importance.

These abstracts from the current literature of science and technology (not including trade journals easily available) were prepared by Drs. Leslie and Coats of The Leslie Laboratories, Traver Road, Ann Arbor, Mich., which will supply, at cost, photostatic copies of original articles. Complete or limited bibliographies covering special topics by title, by abstracts, or in complete manuscript, also may be had by arrangement with the laboratories.

Deasphalting Crude Residuum for Catalytic Cracker. Commercial Production Using Horizontal Settlers and Propane Solvent. E. CLARENCE ODEN AND EDWART L. FORET. *Ind. Eng. Chem.*, **42** (1950), pp. 2088-95.

The propane deasphalting system is believed to have some advantages over the more common vacuum distillation system for removing heavy gas oil from petroleum residues. Data covering the operation of a commercial propane deasphalting unit over a 4-year period are presented. An average of 20,000 barrels per day of crude residuum was charged to this plant to produce approximately 75 volume percent of catalytic cracker feed stock and 25 percent asphalt. Gulf Coastal crudes both sweet and sour were processed through topping units at coil outlet temperatures varying from 650 to 740 degrees F. in order to produce the feed stock for the deasphalting unit. Curves are given that correlate the effect of operating variables on the quantity and quality of the products made. It is shown how the yield and quality of products can be predicted from typical analyses of the feed stock. The effect on yield and quality of product of the purity of the propane and of the propane to oil ratio are shown. Methods of propane recovery are described, and the losses normally encountered are considered. A process flow sheet is given with typical operating conditions, and the unit is described and such matters as operating limitations, flexibility, capacity limitations, maintenance requirements, service factor, and operating labor requirements are discussed.

Chemical Engineering Materials of Construction Review. *Ind. Eng. Chem.*, **42** (1950), pp. 1951-2026.

This is the fourth annual chemical engineering materials of construction review, and presents 13 articles surveying the literature published since the 1949 review. Subjects covered are Aluminum Alloys, Cements, Ceramics, Wrought Copper and Copper Base Alloys; Elastomers; Fibers; Iron, Mild Steels, and Low-Alloy Steels; Nickel and High-Nickel Alloys; Plastics; Hard Rubber; Stainless Steels and Other Ferrous Alloys; Tin and its Alloys and Less Com-

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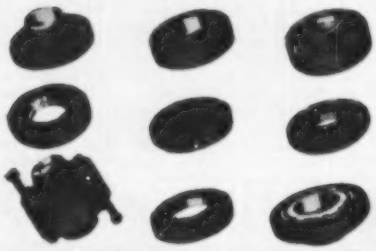

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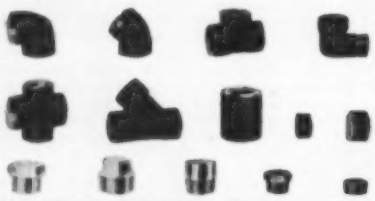

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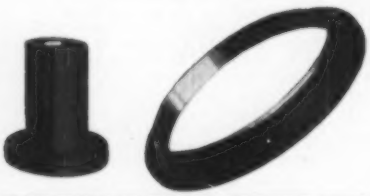

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mon Metals. Following the review articles a 51-page tabular section is presented that lists the chemical and physical properties of many chemical engineering materials. This is the second appearance of tabular data since starting this review.

Hydrogen Fluoride-Boron Trifluoride Extraction of Xylene Isomers. D. A. McCaulay, B. H. Shoemaker, and A. P. Lien. *Ind. Eng. Chem.*, **42** (1950), pp. 2103-7.

Orthooxylene can be separated from its isomers by fractional distillation, but the problem of separating the remaining three isomers is much more difficult. Improved and cheaper methods of separation will greatly increase the demand for the individual xylene isomers. Batch extraction experiments show that m-Xylene can be separated from its isomers by extraction with hydrogen fluoride-boron trifluoride mixture. The $HF\text{-}BF_3$ is separated from the extract by vaporization at moderately low temperature. All of the xylene isomers react rapidly and reversibly with $HF\text{-}BF_3$ to form complexes with one mole of boron trifluoride to one of hydrocarbon. The complex is soluble in excess hydrogen fluoride, but the xylene hydrocarbons are substantially insoluble. The equilibrium constants, representing the stability of each of the xylene complexes, were calculated from the vapor pressure measurements and were found to be in the ratio: meta:ortho:para = 20:2:1. Thus the metaxylene complex is much more stable than the other two, which explains the preferential extraction of metaxylene into the acid extract layer.

Products: Properties, Utilization and Analysis

Precise Laboratory Fractionation—An Automatically Controlled Column. H. C. Highet, G. W. Godin, A. R. Philpotts, and G. H. Twigg. *Jour. Soc. Chem. Ind.*, **69** (1950), pp. 249-54.

The authors describe a method of reducing heat losses from laboratory fractionating columns. Differential thermocouples were used in the insulation to detect radial heat flow and to control the current passing through an electrical heater winding in the lagging. Thermal and electrical characteristics are calculated for equipment required to maintain a number of columns adiabatic by intermittent inspection and control. The apparatus used is described in some detail. Heat losses were negligible and as many as six jackets were controlled simultaneously at temperatures up to 265° C.

High-Efficiency Laboratory Fractionation. V. An Automatic Laboratory Still. O. G. Dison and H. R. Ronnebeck. *Jour. Soc. Chem. Ind.*, **69** (1950), pp. 202-4.

If the importance of accurate control of operating variables throughout a long batch fractionation, extending over nearly 200 hours, is stressed, this can best be achieved by automatic control. A still and accessories are described, for which automatic control is provided for the maintenance of adiabatic conditions in the fractionating column, in the adjustment of reflux ratio to give optimum fractionation efficiency and in the hourly changing of receivers in which the distillate is collected. These operations are controlled by a modified Temperature Recorder, which instrument also provides a record of the important temperatures and operations throughout the progress of the distillation. As a typical example, the use of the still in the fractionation of commercial iso-octane is described.

High-Efficiency Laboratory Fractionation. VI. The Automatic Control of Still-Jacket Temperature. O. G. Dixon. *Jour. Soc. Chem. Ind.*, **69** (1950), pp. 204-5.

A simple and cheap device for automatic control is described which can be used in place of a fully automatic control when the cost of the latter is not justified. Use is made of air thermometers as the temperature-sensitive elements. Pressure difference between two thermometers changes a mercury level and makes electrical contacts that turn the heater on or off by means of a relay.

Symposium on Tetraethyllead in Gasoline. *Analytical Chem.*, **22** (1950), pp. 1230-61.

A symposium of six papers on recent developments in instrumental methods for the determination of tetraethyllead in gasoline is presented. The subjects covered are: the Rapid Determination of Tetraethyllead in Aviation Gasoline, the Rapid Polarographic Determination of Tetraethyllead in Gasoline, Direct-Reading Polarograph for Determination of Tetraethyllead in Gasoline, Determination of Tetraethyllead in Gasoline by

Science and Technology

X-Ray Absorptiometry, X-Ray Absorption Spectrometery for Determination of Tetraethyllead in Gasoline, and X-Ray Fluorescence Analysis of Ethyl Fluid in Aviation Gasoline.

American Methods of Testing Temporary Corrosion Preventives. C. F. McCue and E. R. Blane. *Jour. Inst. of Petroleum*, **36** (1950), pp. 487-94.

The authors review the more important methods used in the United States, both in the laboratory and in the field for determining protection afforded by temporary corrosion preventives. Significance of the results of some of these tests is discussed. It is indicated that no single test can be relied upon to correlate well with practice, but that consideration of two or three different tests in conjunction with one another may lead to a proper conclusion.

Temporary Corrosion Preventives for Aviation Uses and Methods of Testing Them. E. W. J. Marbles and J. Mason. *Jour. Inst. of Petroleum*, **36** (1950), pp. 475-87.

Numerous temporary corrosion preventives are mentioned, including corrosion-preventive lubricants, all of which have been used in connection with aviation. Special features of these temporary protectives are briefly discussed. Methods of testing are considered: Exposure, Accelerated, Mechanical, Special Tests for Engine Corrosion Inhibitors, Bomb Oxidation Tests, and Other Laboratory Tests. Typical results of the Norma-

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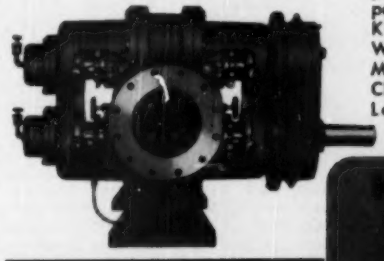

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Science and Technology

Hoffmann Bomb Oxidation Tests are given and discussed, and the importance of this method of testing is stressed, the developing temporary protectives and similar products.

Direct Determination of Oxygen in Compounds Containing Carbon, Hydrogen, and Oxygen. A Physical-Chemical Technique. CHARLES C. HARRIS, DONALD M. SMITH, AND JOHN MITCHELL, JR. *Analytical Chem.*, **22** (1950), pp. 1297-1304.

A truly general method for the determination of oxygen in organic compounds is not yet available. The authors surveyed the literature and came to the conclusion that the technique of Unterzaucher is the one most likely to provide a basis for such a method. A technique is presented for the direct determination of oxygen, based on the Unterzaucher carbon-reduction procedure. The sample is decomposed in a stream of helium and the decomposition products are circulated in a closed system over carbon at 1100 to 1150 degrees C. until conversion of all the oxygen to carbon monoxide is complete. During this circulation, the hydrogen is removed selectively by diffusion through a heated palladium tube. The procedure permits the use of large samples, which is valuable in the analysis of materials of low oxygen content. The composition of the helium-carbon monoxide mixture is determined with a sensitivity of 0.2 percent carbon monoxide per mv. by use of a thermal conductivity bridge. Because the thermal conductivity measurements are referred to control cell, tank helium can be used without further purification. By continuously recording the bridge potential, a means is provided for following the course of the decomposition and conversion. Preliminary results with the method on a wide variety of solid and liquid compounds indicate a relative accuracy of 1 percent or better.

Evaluation of Quality of Paraffin Wax. F. H. MACLAREN. *Ind. Eng. Chem.*, **42** (1950), pp. 2134-41.

Paraffin waxes must have good resistance to "blocking" or sticking and must also possess adequate sealing strength. A new breaking strength test for paraffin wax was developed that is simple and yields reproducible values. The results of this test are expressed in terms of what is called the Indiana Coating Index because of the close relationship of the breaking strength of paraffin wax and its quality as a paper-coating material. There is excellent correlation of the data obtained by the test for sealing strength and blocking. The relationship of the Indiana index values to tensile strength values for paraffin waxes is also shown. Blocking resistance, sealing strength, and tensile strength of paraffin waxes vary inversely with the amount of oil in the wax. Paraffin waxes that show a high Indiana coating index contain less oil than that shown by the usual solvent methods of analysis. The author concludes that substantial improvement has been made in evaluation methods for paraffin wax qualities.

Chemicals Wanted

The National Registry of Rare Chemicals, Armour Research Foundation, 33rd, Federal and Dearborn Streets, Chicago 16, has received urgent requests for the chemicals listed below. If anyone has one or more, even if only one gram quantities, please inform the Registry.

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3,3-Dichloropropene-1
Heptacosane
3-Hexene-1-ol
5-Methylhexane-1-ol
1-Methyl-4-methylol-glyoxaline
1-Methyl-4-methylol-imidazole
β-Dimethylcholine
1,3-Diphenylbenzofuran
N-methylthioacetamide
bis-(2-Hydroxy-5-chlorocyclohexyl)
1,1-Dimethylhydrazine
Nonanetetrol-2,4,6,8
β-Fluoropropionic acid
Thiocyclooctane
Hexane-3-thiol
Decafluorocyclopentane

Fundamental Physical and Chemical Data

Pressure-Volume-Temperature Relationships of Gaseous Normal Hydrogen from Its Boiling Point to Room Temperature and from 0 to 1000 Atmospheres. H. L. JOHNSTON AND DAVID WHITE. *Trans. Am. Soc. Mech. Engrs.*, **72** (1950) pp. 785-7.

The Cryogenic Laboratories of Ohio State University has gathered data over a long period of years and presents a summary of accurate measurements of data of state for normal Hydrogen. The results presented cover a wide range of temperature and pressure.

The Vapor Pressure of Normal Hydrogen from the Normal Boiling Point to the Critical Point. DAVID WHITE, ABRAHAM SOLOMON FRIEDMAN AND HERRICK L. JOHNSTON. *Jour. Am. Chem. Soc.*, **72** (1950), pp. 3927-30.

The vapor pressure of hydrogen from the boiling point to the critical point was determined and can be represented by the equation $\log P_{atm} = 3.068281 - 55.25642/T - 3.1282 \times 10^{-2} T - 6.6989 \times 10^{-4} T^2$. The boiling point calculated from this equation is 20.40° K. The heat of vaporization at the boiling point is 218.7 cal./mole, which compares with 214.8 for pure para hydrogen. The authors discuss the para ortho hydrogen equilibrium in relation to their work.

The Vapor Pressure of Liquid Nitrogen. ABRAHAM SOLOMON FRIEDMAN AND DAVID WHITE. *Jour. Am. Chem. Soc.*, **72** (1950), pp. 3931-2.

Many investigations of the vapor pressure of nitrogen have been made, but only two in this country have measured the vapor pressure above one atmosphere. The authors therefore measured the vapor pressure from the boiling point to the critical point as part of a general investigation of the data for nitrogen. The nitrogen used contained less than one-hundredth mole percent of impurities. Vapor pressures were found to be accurately represented by the equation

$$\log P_{atm.} = 3.720822 - 293.04358/T + 10.31993 \times 10^{-4} T.$$

The calculated boiling point of nitrogen is 77.34°K and the molal heat of vaporization at the boiling point is 1320 cal./mole.

Vapor-Liquid Equilibria at Subatmospheric Pressures. Tetradecane-Hexadecene System. R. R. RASMUSSEN AND MATTHEW VAN WINKLE. *Ind. Eng. Chem.*, **42** (1950), pp. 2121-4.

Vapor-liquid equilibrium data for the binary system tetradecane-hexadecene are presented at absolute pressures of 760, 400, 200, 100, 50, 20, and 10 mm. The hydrocarbons used were practically pure hexadecene and tetradecane as indicated by iodine value, molecular weight, index of refraction, and carbon and hydrogen analysis. The activity coefficient curves indicate that the binary system of these hydrocarbons is almost ideal in its Raoult's law behavior at the pressures studied. The closest approach to Raoult's law ideality was found at 200 mm. absolute pressure. The data was tested by the use of a modified Duhem equation and were found to be thermodynamically consistent. The data are presented in some detail in tabular and graphical form.

New Measurements of the Heat Conductivity of Steam and Nitrogen. F. G. KEYES AND D. J. SANDELL, JR. *Trans. Am. Soc. Mech. Engrs.*, **72** (1950), pp. 767-78.

The authors review work done on the thermal conductivity of steam from approximately 100 to 550° C. and up to pressures of 250 atmospheres, particularly the work of Timrot and Vargaftik, who used the hot-wire type of conductant cell, in which a pure platinum wire serves as the thermal emitter, and changes in its electrical resistance provide the temperature indication. The new measurements reported were obtained with a concentric cylinder type of conductivity cell in which the heater and thermometric parts were isolated from contact with the material, the conductivity of which was being measured. Previous data on the thermal conductivity of nitrogen in the same type of cell used for steam are reviewed. New measurements made are in fairly good agreement with the Vargaftik measurements, but the new measurements for steam are considerably lower.

Condensed Gas Calorimetry. I. Heat Capacities, Latent Heats and Entropies of Pure Para-Hydrogen from 12.7 to 20.3° K. Description of the Condensed Gas Calorimeter in Use in the Cryogenic Laboratory of the Ohio State University. HERRICK L. JOHNSTON, JOHN T. CLARKE, ELLIS B. RIFKIN AND EUGENE C. KERR. *Jour. Am. Chem. Soc.*, **72** (1950), pp. 3933-8.

The authors point out that it was not until 1928 that the existence of the ortho and para forms of hydrogen were recognized. All previous studies of hydrogen were made with mixtures of these forms. The hydrogen employed was 99.8 percent para hydrogen prepared by equilibrium treatment over charcoal at 20.3°

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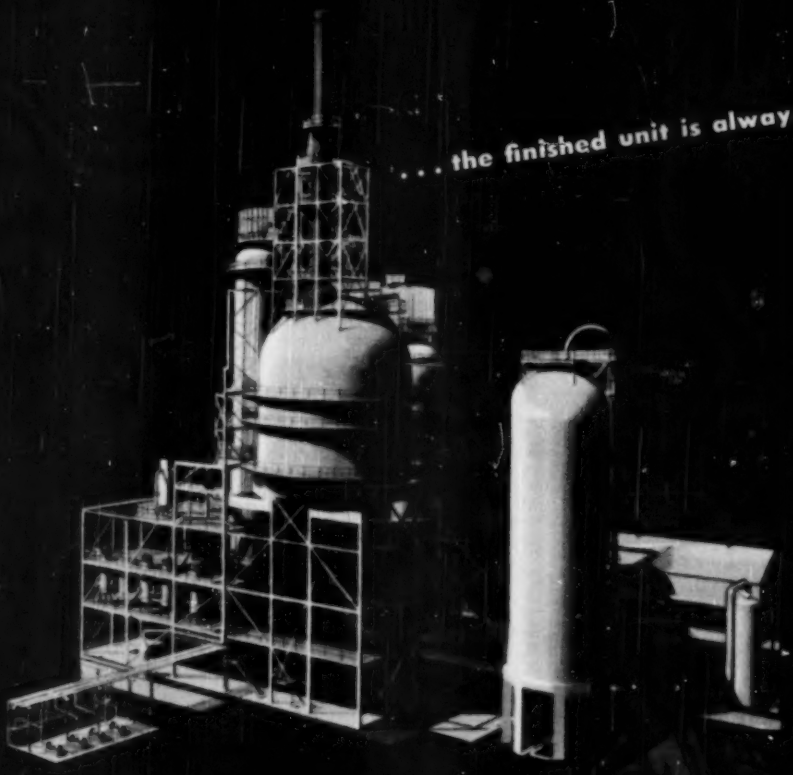

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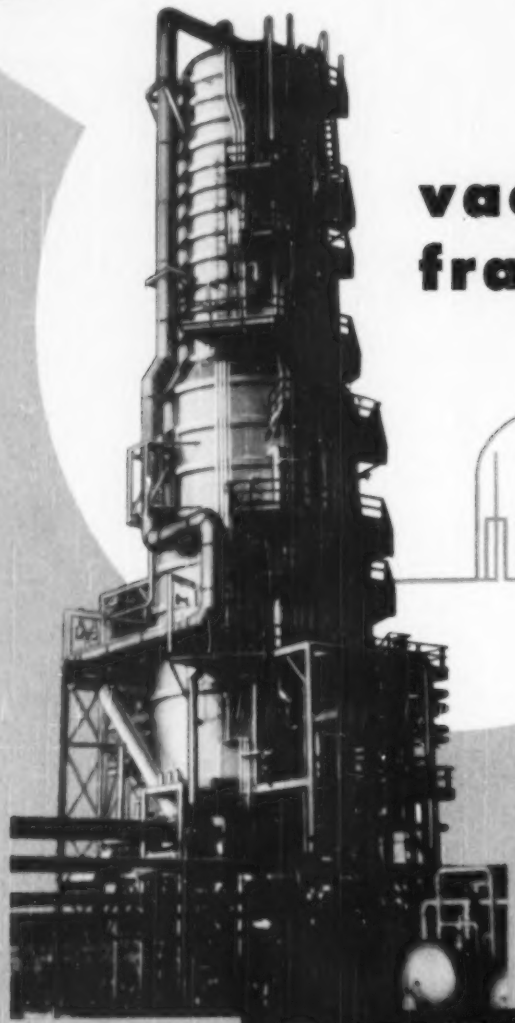

vacuum fractionation

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K. The heat capacities and latent heats of solid and liquid para hydrogen were measured over the temperature range 11.5 to 20.3° K. Pressure and temperature at the triple point are 52.76 mm. and 13.84° K respectively. Heats of fusion and of vaporization are 28.08 ± 0.15 and 214.8 ± 0.4 cal. per mole, respectively. The entropy of the gas at the normal boiling point, corrected for both gas imperfection and "frozen in entropy," due to the presence of 0.2 of 1 percent of ortho hydrogen, is 14.83 ± 0.1 entropy units. This compares with the statistically calculated value of 14.76 e.u. The heat of vaporization of normal hydrogen at its boiling point (20.38° K) is 219.3 cal. per mole, based on the data of this investigation for para hydrogen and on the vapor pressure data and density data for normal and for para hydrogen.

The Compressibility of and an Equation of State for Gaseous 1-Butene. JAMES A. BEATTIE AND STANLEY MARPLE, JR. *Jour. Am. Chem. Soc.*, **72** (1950), pp. 4143-5.

The compressibility of gaseous 1-butene from 150 to 250° C. and from 1 to 8 moles per liter was measured. The results to 4 moles per liter were fitted to an equation of state. The constants of the Beattie-Bridgeman equation of state for 1-butene (molecular weight 56.0616) are: R = 0.08206, A_o = 16.1679, a = 0.11988, B_o = 0.24046, b = 0.10690, c = 300×10^4 in units of normal atmospheres, liters per mole and degrees K. It was found that the polymerization of 1-butene was slow at 200° C., but becomes rapid at 250° C.

The Thermodynamic Properties of Helium. S. W. AKIN. *Trans. Am. Soc. Mech. Engrs.*, **72** (1950), 751-7.

The density, enthalpy, entropy, viscosity, and thermal conductivity of Helium were determined at pressures from atmosphere to 6000 lb. per sq. in. and in the temperature range, —440° F. to 600° F. The data studied were published values prior to 1945 and also extrapolations based on the Beattie-Bridgman equation of state and kinetic theory. These are presented in tabular and graphical form with sufficient accuracy for investigations of flow and heat-transfer processes concerned with high-pressure helium.

Chemical Composition and Reactions

Hydrocarbons. XI. Synthesis of Nineteen Decenes. CARLYLE J. STEHMAN, NEWELL C. COOK, WILLIAM C. PERCIVAL AND FRANK C. WHITMORE. *Jour. Am. Chem. Soc.*, **72** (1950), pp. 4163-5.

The syntheses of the decenes described by the authors were made for the purpose of providing reference olefins for comparison with diamylenes made by the polymerization of t-amyl alcohol. A second purpose achieved in the study of alcohol dehydration has been extended to highly branched decanols. Nineteen decenes were obtained by precise fractionation of the dehydration mixtures. Most of these compounds were characterized by boiling point, refractive index, Raman spectra, the density and viscosity, and were defined as to structure by ozonolysis. Dehydration of the alcohols with formation of methylene and ethylidene olefins predominated. Only small amounts of olefins with double bonds connecting tertiary carbon atoms were formed. Small quantities of products in which a single 1,2-rearrangement of a methyl or ethyl group occurred were formed. No product was formed involving a 1,3-rearrangement, or involving more than a single shift.

Isomerization of Saturated Hydrocarbons. VII. The Effect of Light Upon the Isomerization of Methylcyclopentane in the Presence of Aluminum Bromide-Hydrogen Bromide. HERMAN PINES, EUGENE ARISTOFF AND V. N. IPATIEFF. *Jour. Am. Chem. Soc.*, **72** (1950), pp. 4055-6.

The work was an extension of previous work designed to determine whether the isomerization of methylcyclopentane can proceed without the addition of a chain initiator, such as traces of olefins or alkyl halides. Isomerization was found to proceed when a reaction tube containing methylcyclopentane, aluminum bromide and hydrogen bromide in a molal ratio of approximately 100:2:1, was exposed for nine hours to a quartz cadmium-mercury vapor arc lamp. When a quartz tube, rather than a Pyrex tube was used the isomerization was increased from 18 to 24 percent. In some experiments small amounts of non-condensable gases were produced during the reaction. These were collected and found to be over 97 percent of hydrogen. The results obtained are in accordance with a chain mechanism of isomerization.

Studies in the Terpene Series. IX. Isomerization Accompanying Cycloalkylation of Benzene. V. N. IPATIEFF, H. R. APPELL AND HERMAN PINES. *Jour. Am. Chem. Soc.*, **72** (1950), pp. 4260-2.

The investigators found that the reaction of benzene with disubstituted cyclohexenes in the presence of hydrogen fluoride was accompanied by a hydrogen shift. In general the phenyl group was attached mainly to the carbon atom of the cyclohexyl ring having the smallest alkyl group. Several new compounds were prepared: 1-methyl-4-ethyl-, 1-ethyl-4-isopropyl-, and 1-isopropyl-4-ethylcyclohexanol.

Science and Technology

The Pyrolysis of Isobutylene. FRANCIS OWEN RICE AND LEO A. WALL. *Jour. Am. Chem. Soc.*, **72** (1950), pp. 3967-8.

The thermal decomposition of isobutylene is very sensitive to the conditions of pressure, temperature, and contact time. The authors made their runs using a quartz tube and also a chrome steel tube of the same dimensions. Eight runs were made at temperatures in the range 850-900° C. and in the pressure range 50-200 mm. The contact time was a few tenths of a second. The data are presented in detail in tabular form. The principal low molecular weight products were methane, allene and methyl-acetylene accompanied by much smaller amounts of hydrogen, propylene, ethane and ethylene. Although the formation of tar and carbon was avoided, there was some formation of aromatic compounds such as benzene, toluene, naphthalene, and anthracene. Mesitylene was found to be absent.

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Digest of Recent U. S. PATENTS Pertaining to PETROLEUM REFINING

Compiled by HEINZ HEINEMANN

(From the Official Gazette, September 19, 26 and October 3 and 10, 1950.)

CRACKING AND REFORMING

U.S.P. 2,522,922. Process of Making a Composite Oil Gas Having Approximately the Characteristics of Natural Gas. H. M. Blain, Jr., to The Gas Machinery Company.

Details are claimed of a cyclic process for making oil gas of about the characteristics of natural gas from hydrocarbon oil and steam at cracking temperatures.

U.S.P. 2,525,152. Process for Stabilizing Gasoline. B. R. Strickland and E. H. Lewis to Standard Oil Development Company.

A gas oil feed stock boiling above 400° F. and containing more than 0.8 percent sulfur is catalytically cracked. On fractioning the reaction products, a distillate fraction is obtained which boils in the gasoline range and is substantially free of H_2S but contains substantial amounts of aromatic mercaptans formed in the cracking operation. This distillate stock which contains both olefins and diolefins is contacted with an aqueous alkali hydroxide solution in the absence of free oxygen. A gum stable gasoline substantially free of mercaptan sulfur is obtained.

U.S.P. 2,525,153. Process for Recovering Aromatic Mercaptans from Catalytic Gasoline. J. K. McClennan and B. R. Strickland to Standard Oil Development Company.

The process of this patent is related to that of U.S.P. 2,525,152. The extract formed by treating catalytically cracked gasoline with an aqueous solution of NaOH or KOH in the absence of oxygen is acidified to a pH of about 9. An oily phase formed which comprises the aliphatic mercaptans and phenols is withdrawn. The remaining hydroxide extract is further acidified to a pH of about 2. The second oily phase thus separated comprises the aromatic mercaptans which are recovered.

U.S.P. 2,525,276. Method of Cracking Hydrocarbons. J. H. Shapleigh to Hercules Powder Company.

Finely-diffused or gaseous hydrocarbon is flowed along an inner path in a cracking tube while a gaseous medium, e.g., steam, is flowed concurrent therewith along an outer concentric path in contact with the cracking tube. This tube is heated to superheat the gaseous medium, and the hydrocarbon is caused to flow from the inner path to the outer to mix directly with the gaseous medium. The resulting mixture is immediately passed through the cracking tube while applying heat to bring about satisfactory cracking without appreciable carbon deposition.

CATALYST PREPARATION, ACTIVATION, AND REGENERATION

U.S.P. 2,522,641. Aluminum Salt Composition and Process for Producing Same. L. Schmerling to Universal Oil Products Company.

Equimolecular proportions of aluminum chloride or bromide and of a monobasic aluminum acid salt of an alkanoic acid having a dissociation constant of less than 1×10^{-5}, e.g., monobasic aluminum acetate, are reacted until one mol proportion of hydrogen halide has been liberated. The resulting product of the formula $X_2Al\text{-}O\text{-}Alm\ (O\text{-}CO\text{-}R)_3$ wherein R is an alkyl group and X is Cl or Br is useful as a catalyst.

U.S.P. 2,524,566. Production of Copper-Magnesia Hydrogenation Catalyst and its Use in Hydrogenation Reactions. J. P. W. Houtman and G. C. A. Schuit to Shell Development Company.

Hydrogenation processes, such as the hydrogenation of aromatic hydrocarbons or that of an oxide of carbon, are effected with a catalyst which consists of a reduced coprecipitate of Cu and Mg. This catalyst is formed by adding a NaOH-solution to an aqueous solution of copper nitrate and magnesium nitrate while maintaining the pH of the resulting mixture between 7.5 and 9.5. To the resulting reaction mixture containing precipitated basic copper nitrate and $Mg(OH)_2$ sufficient NaOH is added to increase the pH to above 12, whereby the remainder of the magnesium is precipitated as the hydroxide. The then separated combined precipitate is dried and reduced.

U.S.P. 2,524,572. Catalyst Feeder. R. H. Riemenschneider to The Lummus Company.

Details are claimed of a feeder device for granular material such as catalysts. This feeder protects the grains of material from breakage or abrasion during their transfer.

U.S.P. 2,524,771. Supported Metal Oxyfluoride Cracking Catalyst. S. M. Darling to The Standard Oil Company of Ohio.

An alumina cracking catalyst contains 5-30 percent by weight of separately formed Be, Ti, or Zr oxyfluoride as primary promoter. The catalyst has high activity and conversion indices, and the cracking products show an unexpectedly high octane number.

U.S.P. 2,524,809-10. Preparation of Hydrogel Catalyst. C. N. Kimberlin, Jr., to Standard Oil Development Company.

To an aqueous solution of a soluble salt of Al, Cr, Fe, Ti, Zr, Sn, or Th containing at least 50 g. of the metal oxide per liter, at least a stoichiometrically equivalent amount of magnesia is added. A true hydrogel of the metal is formed.

U.S.P. 2,525,073. Magnesia-Ceria and Magnesia-Beryllia Catalysts. C. N. Kimberlin, Jr., to Standard Oil Development Company.

The process for the preparation of the hydrogels differs from those of U.S.P. 2,524,809-10 substantially only in that soluble salts of Ce or Be are here subjected to the treatment.

U.S.P. 2,525,144. Manufacture of Improved Solid Phosphoric Acid Catalyst. J. M. Mavity to Universal Oil Products Company.

In the manufacture of solid catalysts from a phosphoric acid and a siliceous adsorbent, 0.5-5 percent by weight of a fatty acid with at least 10 C atoms, or of Al-or group II metal salt of such fatty acid, such as aluminum stearate, is incorporated into the wet paste formed by mixing said ingredients. The crushing strength of the catalyst formed by drying and calcining said paste is increased by the additive.

U.S.P. 2,525,145. Supported Phosphoric Acid-Boric Acid Catalyst and its Manufacture. J. M. Mavity to Universal Oil Products Company.

A solid catalyst is produced by mixing 60-80 percent by weight of a phosphoric acid and 40-20 percent of a mixture of solids comprising 80-20 percent of a siliceous adsorbent and 20-80 percent of boric acid or boric anhydride, drying and calcining the mixture.

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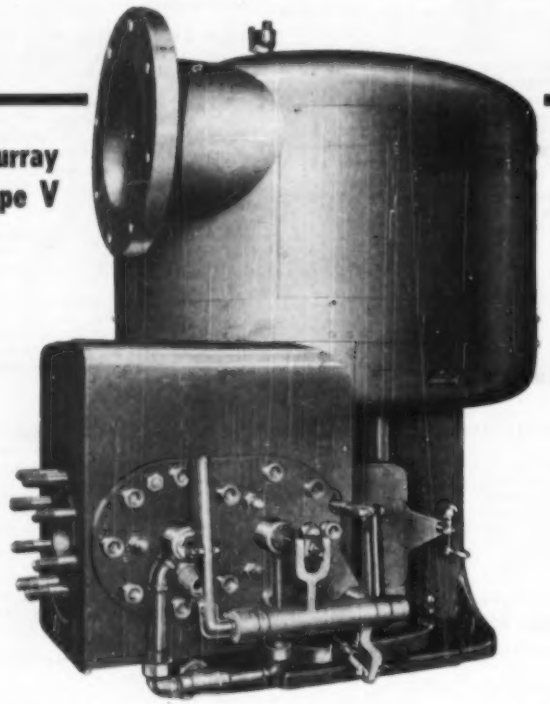

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REFINING

U.S.P. 2,522,490. Mineral Oil Compositions Containing Trithienyl-Trithio-Orthoformate. J. W. Brooks to Socony-Vacuum Oil Company, Inc.

A mineral oil contains less than 10 percent of trithienyl-trithio-orthoformate. The additive diminishes the production of acidic compounds in the oil under oxidizing influences.

U.S.P. 2,522,518-9. Stabilized Ammonium Mahogany Sulfonates. M. P. Kleinholz and T. A. Hack to Sinclair Refining Company.

A mineral oil composition consists of a neutral oil solution of 10 percent by volume of ammonium mahogany sulfonate and 0.1-2 percent by volume of an oil-soluble alcohol with not less than 3C atoms, such as iso-propyl or amyl alcohol. This additive stabilizes the composition against precipitate formation on storage. According to U.S. patent 2,522,519 aniline is employed as the stabilizing additive.

U.S.P. 2,522,618. Extraction of Aromatic and Sulfur Compounds. C. E. Johnson and A. A. Harban to Standard Oil Company of Indiana.

A mixture of aliphatic hydrocarbons and aromatic hydrocarbons and/or organic sulfur compounds, such as a light cracked gas oil, is contacted with a selective solvent consisting of an amine salt of a sulfonic acid of the formula

$$\left.\begin{matrix} R_1 \\ R_2 \\ R_3 \end{matrix}\right\rangle N \cdot R_4SO_3H$$

wherein R_1 and R_2 are hydrogen or saturated hydrocarbon radicals, R_3 is a hydrocarbon radical with at least 2 C atoms, and R_4 is a saturated or an aromatic hydrocarbon radical. The amine salt shall contain 4-20 C atoms. The resulting extract phase contains the aromatic hydrocarbons and/or the organic sulfur compounds. The triethylamine salt of p-toluene-sulfonic acid is an example of these selective solvents.

U.S.P. 2,522,619. Extraction of Oxygenated Compounds. A. A. Harban and C. E. Johnson to Standard Oil Company of Indiana.

The method according to U.S. patent 2,522,618 is employed for separating a neutral oxygenated organic compound from its solution in an aliphatic hydrocarbon.

U.S.P. 2,522,640. Separation of Hydrocarbon Gases at Low Temperatures. M. Ruhemann to Petrocarbon Ltd., London.

In the separation of hydrocarbon gases from a gaseous mixture of alkanes and alkenes with not more than 5 C atoms, a stream of this mixture is compressed and cooled to a temperature of —100° to —138° C. to liquefy the hydrocarbons. An amount of methanol is added to the gaseous stream prior to cooling sufficient to form with the water present in the gases a methanol-water mixture having a freezing point below the cooling temperature. The methanol-water mixture formed as a separate layer beneath the hydrocarbon layer is removed.

Patents

U.S.P. 2,522,678. Recovery of Oxidized Petroleum Products. A. P. Kozacik and A. N. Sachanen to Socony-Vacuum Oil Company, Inc.

Details are claimed of a process for the partial oxidation of hydrocarbons and for further treatment of the mixture of products thus obtained to separate the components.

U.S.P. 2,523,549. Deoxygenation of Hydrocarbons. W. N. Axe to Phillips Petroleum Company.

A liquid hydrocarbon stream free from H_2S, mercaptans and water but containing not more than 10 cc per liter of free or loosely combined oxygen is intimately contacted at a temperature of 32-115° F. and a pressure up to 100 psi. with a solid reagent comprising a disalicylal-ethylenediimine-cobalt supported on a porous, inert, granular material and prepared in a manner claimed in detail. The oxygen is removed by this treatment from the hydrocarbon stream.

U.S.P. 2,523,149. Fractionation of Gases with Solid Adsorbents. H. W. Sheeline to Standard Oil Development Company.

Details are claimed of a process for concentrating an intermediate component from a vaporous hydrocarbon mixture, particularly for concentrating a C_3 hydrocarbon fraction from a gas mixture containing C_1-C_5 hydrocarbons, by means of a fluidized solid adsorbent, such as charcoal.

U.S.P. 2,523,672. Diesel Fuel. A. B. Wilder to The Pure Oil Company.

A hydrocarbon fuel for diesel type engines contains a small amount of tert. butyl perbenzoate or tert. amyl perbenzoate or tert. amyl perbenzoate to boost the cetane number of the fuel.

U.S.P. 2,523,681. Solvent Extraction of Unsaturated Hydrocarbons. R. M. Cole to Shell Development Company.

Unsaturated hydrocarbons are separated from a hydrocarbon mixture by contacting this mixture with a homogeneous aqueous phenol solution of water-soluble $AgNO_3$, AgF, silver fluosilicate, perchlorate, lactate, or acetate, wherein the silver salt and phenol are present in the weight ratio of 1:1 and the solution contains 10-12 percent by weight water.

U.S.P. 2,523,747. Recovery of Gasoline from Enriched Absorber Oils. J. J. Weatherby to The Stearns-Roger Manufacturing Company.

Details are claimed for separating desired products from an absorber oil enriched in gasoline components and in hydrocarbons lighter and heavier than gasoline.

U.S.P. 2,524,864. Fuel Oil Composition. C. Wies, J. B. R. Caron, and E. B. Glendenning to Shell Development Company.

A fuel oil contains 0.0025-0.005 percent of a polyhydric alcohol-poly basic acid resin, e.g. glycerol-phthalic anhydride resin, and 0.0025-0.0042 percent of a salt

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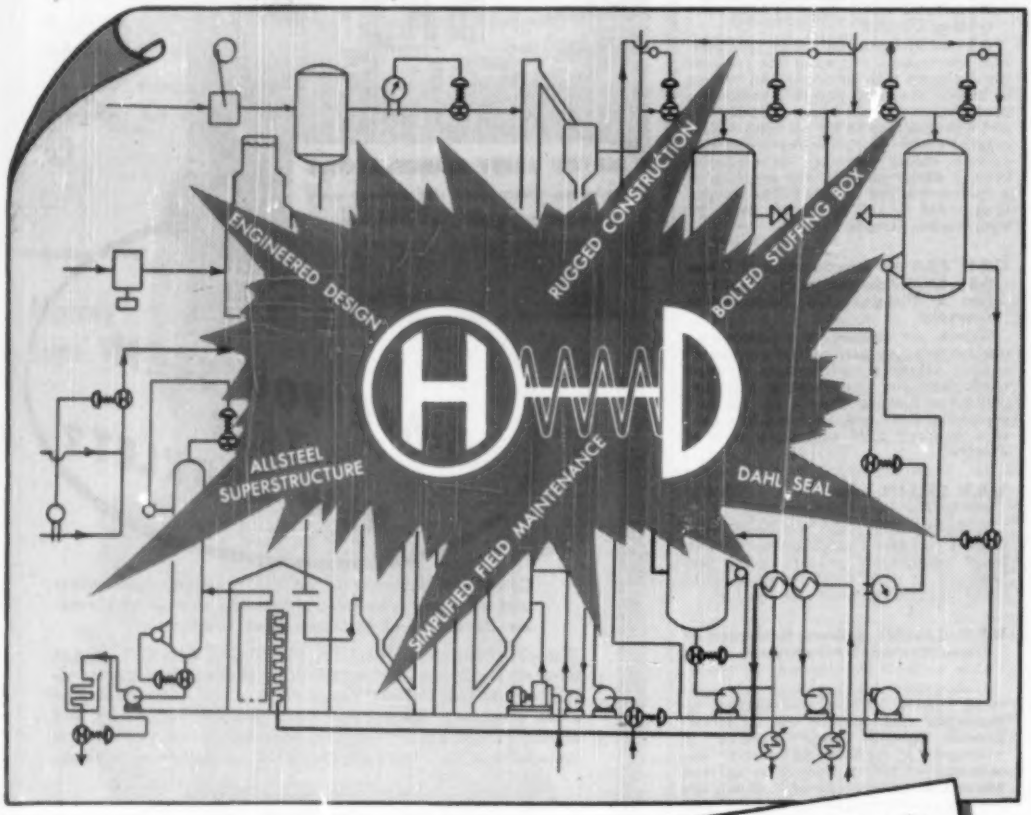

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In Canada, Railway & Power Engineering Corporation, Ltd.

of an organic acidic compound, such as the barium salt of alkyl phenol disulfide. The additives inhibit clogging of the oil.

U.S.P. 2,524,889-92. Processes for Breaking Petroleum Emulsions. M. De Groote and B. Keiser to Petrolite Corporation, Ltd.

Petroleum emulsions of the water-in-oil type are broken by the use of a demulsifying agent including hydrophile synthetic products of certain complex combinations. These products are oxyalkylation products of an alpha-beta alkylene oxide with not more than 4 C atoms and certain fusible phenol-aldehyde resins soluble in organic solvents but insoluble in water. An anacardic acid phenol is employed in the preparation of this resin.

POLYMERIZATION AND CONVERSION

U.S.P. 2,522,696. Catalytic Conversion of Naphtha for the Production of High Antiknock Gasoline. K. M. Watson to Sinclair Refining Company.

Naphtha of relatively high hydrogen content is contacted with a dehydrogenation catalyst at a temperature of 900-1100° F. at atmospheric pressure. The reaction products are separated into free hydrogen, aromatic hydrocarbons and a non-aromatic cracked naphtha stock. This stock is further continuously cracked with addition of a stock difficult to crack in the presence of the hydrogen produced in the first reaction step and of a hydrogenating cracking catalyst at a temperature of 700-1100° F. and a pressure of 300-3000 psi. A high antiknock gasoline is recovered.

U.S.P. 2,523,150. Resinous Copolymers of Diolefins with Refinery C$_4$ Cuts. H. G. Schneider and D. W. Young to Standard Oil Development Company.

A mixture of equal proportions of a multiolefin with 4-14 C atoms, e.g. butadiene, and a refinery C$_4$ cut composed of about half of its volume of propane, butane, isobutane, 15-35 percent of isobutylene, about 27 percent of normal butenes, etc., is cooled to +15° to —35° C. and polymerized in the presence of a Friedel-Crafts metal halide catalyst dissolved in a low freezing, non-complex forming solvent, e.g. methyl chloride. A hard, non-elastomer resin of a m.p. 75-117° C. and very light color is produced.

U.S.P. 2,523,168. Method of Polymerizing Hydrocarbons. C. F. Van Berg to Standard Oil Development Company.

An agitated mixture of 53 parts of isobutylene and 1 part of isoprene is treated with a solution of a Friedel-Crafts catalyst at a temperature of —120° to —175° F. Further portions of the chilled hydrocarbon mixture are continuously introduced at a plurality of points into the agitated mixture. The polymer formed is continuously recovered.

U.S.P. 2,523,289. Modifying Agents for Use in Low-Temperature Polymerization Reactions. P. K. Frolick to Jasco, Inc.

In the polymerization of an iso-olefin

These castings are sections of a special fractionating column, cast and flanged as illustrated at the right; machined and finished at the left.

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THE DURALOY COMPANY

with 4-8 C atoms at low temperature in the presence of a fluid Friedel-Crafts catalyst, the polymer slurry in unpolymerized olefin formed is discharged at elevated temperature into water containing 1-4 percent of a water insoluble metal soap of a fatty acid with 6-18 atoms and a wetting agent for this soap. A stable slurry of the polymer in warm water is obtained.

U.S.P. 2,523,596. Emulsion Polymerization in the Presence of a Mercaptan Modifier. W. A. Schulze and J. E. Troyan to Phillips Petroleum Co.

An aqueous emulsion of butadiene and styrene is copolymerized at a temperature of 80-125° F. in the presence of a small amount of a tert hexadecyl mercaptan and under specific other conditions.

U.S.P. 2,524,627. Suspension Polymerization of Vinyl Compounds. W. P. Hohenstein to Polytechnic Institute of Brooklyn.

Styrene and styrene derivatives are polymerized in aqueous suspension in the presence of 0.1-0.2 percent (by weight of the styrene compound) of suspended finely divided particles of tricalcium phosphate. The polymer is obtained in the form of discrete particles or "pearls."

HYDROGENATION, DEHYDROGENATION, AROMATIZATION

U.S.P. 2,523,248. Separation of Alcohols and Acids from Fischer-Tropsch Synthesis Product. B. Heinze and J. A. King to Cities Service Oil Company.

The oily and aqueous fractions of a Fischer-Tropsch synthesis product are jointly fractionally distilled without neutralization of the acids present. A vapor product comprising water, oily hydrocarbon constituents, and the alcohols present is taken overhead. The recovered bottoms product comprises water, oily hydrocarbon constituents, and the organic acids present.

U.S.P. 2,523,284. Method of Manufacturing Hydrogen and Carbon Monoxide. duBois Eastman to The Texas Company.

A process is described for the preparation of synthesis gas by conversion of normally gaseous hydrocarbons, in which an endothermic and an exothermic reaction zone are provided. A particle-form catalyst-bearing heat carrier is continuously moved through both zones in succession. Gaseous hydrocarbons are subjected to combustion by oxygen in the exothermic zone, heating the catalyst to over 2000° F. prior to its passing to the endothermic zone. A separate stream of the gaseous hydrocarbons and the hot combustion gases from the exothermic zone consisting of CO_2 and H_2O are continuously fed to the endothermic zone there to produce the CO/H_2 mixture.

U.S.P. 2,524,840. Hydrogen Production. J. H. Shapleigh to Hercules Powder Company.

Details are claimed of a process for producing hydrogen from gaseous or atomized petroleum hydrocarbons and steam in the presence of a nickel catalyst.

U.S.P. 2,525,080. Method for Synthesis of Hydrocarbons and Oxygenerated Organic Compounds. J. C. Schiller to Standard Oil Development Company.

A CO/H_2 mixture is contacted at increased temperatures and pressures with a catalyst prepared by reducing at a temperature of 700-1600° F. a mass comprising a major portion of iron oxide and a minor portion of an alkali metal trioxalato ferriate. Hydrocarbons and oxygenated hydrocarbons are produced in substantial amounts.

DESULFURIZATION

U.S.P. 2,524,088. Gas Purification Process. J. A. Shaw to Koppers Company, Inc.

Industrial gases are freed from organic sulfur compounds by scrubbing with a solution of an amine, such as piperidine, and phenol in a hydrocarbon oil. Sulfur compounds and amine vapors are stripped out, and the stripped vapors are treated with an acidic-reactant solution to absorb the amine and set free the sulfur vapors.

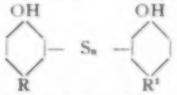
U.S.P. 2,525,583. Removal of Acidic Sulfur Compounds form Hydrocarbon Oils. D. C. Bond and N. B. Russell to The Pure Oil Company.

Mercaptan sulfur compounds occurring in hydrocarbon oil are oxidized to disulfides by contacting them with a gas containing free oxygen in the presence of aqueous alkali solution containing a small, oxidation promoting amount of substantially all the constituents of wood tar boiling between 240-300° C. and extracted therefrom by an aqueous solution with a pH of 1-11, in a vol. ratio of about 25-75 parts of solution per part of tar. Constituents of the wood tar which are insoluble in the aqueous solution are removed before the contacting operation. The method can also be employed for removing mercaptide sulfur from alkali solutions used in extracting mercaptans from hydrocarbon oils.

HEAVY OILS AND WAXES

U.S.P. 2,523,100. Mineral Oil Composition and Additive Therefor. L. T. Eby to Standard Oil Development Company.

A mineral lubricating oil contains 0.05-5 percent of a compound of the formula



where R and R' are alkyl radicals with at least 4 C atoms, each, n is a number of 1-4, and wherein there is attached to the benzene nuclei one or two organic ammonium radicals of specific constitution. The additive inhibits oxidation of the oil, disperses sludge and has valuable properties for extreme pressure lubricants.

U.S.P. 2,525,076 Pour Depressants. L. A.

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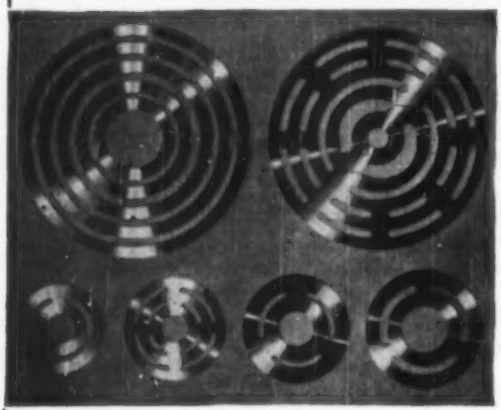

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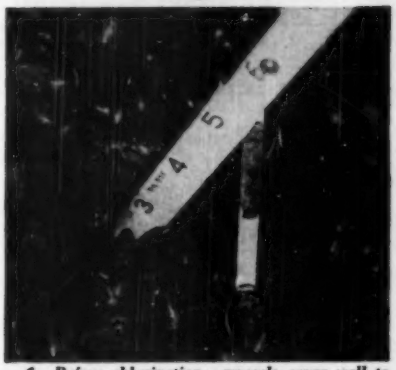
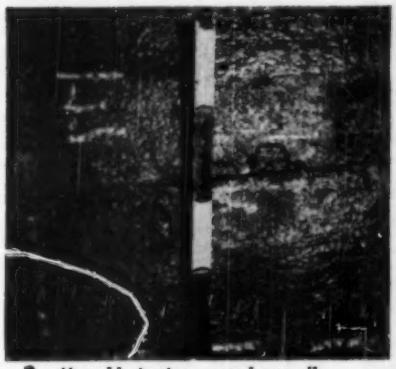
CHLORINATION BY WALLACE & TIERNAN

CONTROLS MARINE FOULING AT GENERATING STATION

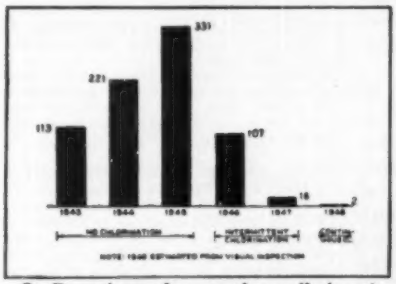
LOOK AT THESE RESULTS



1. Before chlorination — mussels cover wall to depth of 3".



2. After chlorination — note bare wall.



3. Tons of mussels removed annually from intake tunnel of generating station.

It all began when a New England generating station sent down a diver for a routine inspection of the large, concrete, circulating-water, intake tunnel located approximately 13 feet below the harbor's surface. The diver discovered this intake was lined with unusually heavy growths of common mussel (Mytilus), sea moss (Tubularia), and sea anemone (Metridia).

These were expensive visitors. First, mussel accumulation created poor vacuum as the mussels lodged in condenser tubes and aggravated slime and silt formation. Then, as the mass increased in quantity, it became necessary to clean the intake tunnel every year to remove up to a maximum of 331 tons of mussels — a time consuming process that cost thousands of dollars in labor and equipment outage.

To combat these conditions a long and thorough study was made of marine fouling. As a result it was decided to use intermittent chlorination applied by Wallace & Tiernan Chlorinators. First to fall under this attack were the sea moss and the sea anemone. The tougher mussels however, still remained as numerous as ever.

In an all out effort to get rid of these trouble makers, continuous chlorination at heavier residuals was started. This treatment turned the trick and the mussels were reduced to such a low level that yearly cleaning has not been required.

These results saved the New England company thousands of dollars annually by eliminating intake tunnel cleaning, reducing condenser outages, and producing a higher vacuum with a resultant saving in fuel.

Perhaps your problem is one of slime or fouling due to some other marine organism. In any event, if biological fouling is costing you money through lowered cooling water efficiency it's a safe bet that chlorination can help.

See your nearest Wallace & Tiernan Representative now for all the details.

CD-34

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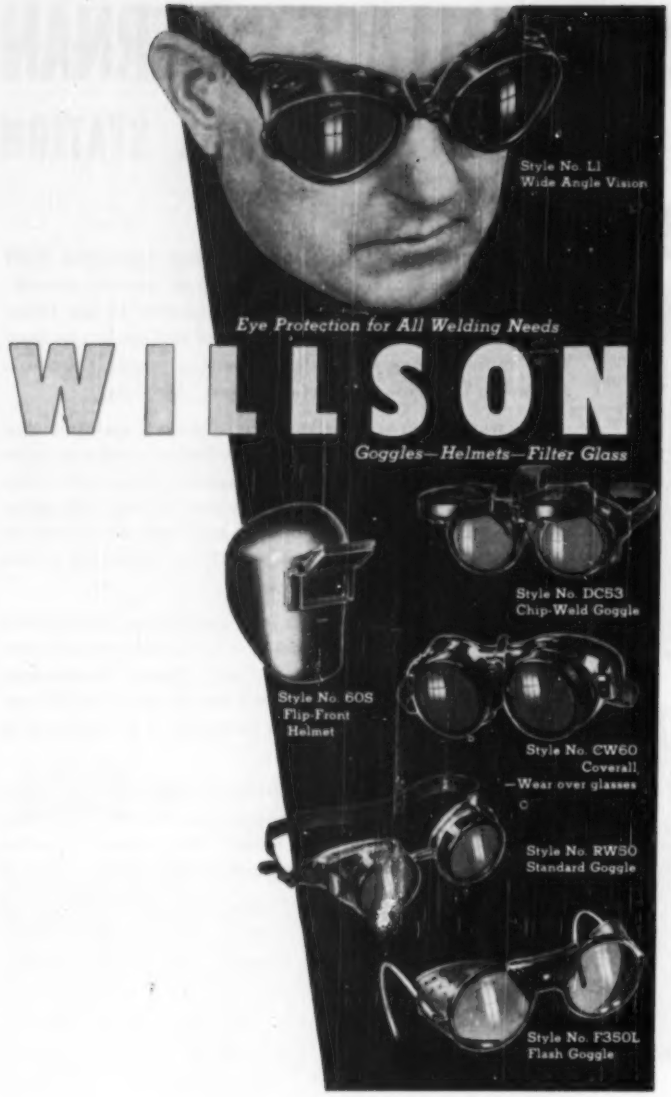

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Patents

Mikesha and S. B. Lippincott to Standard Oil Development Company.

A lubricating oil composition essentially consists of a waxy mineral oil base and 0.1-5 percent of a product obtained by heating a mixture of at least two different aliphatic carboxylic acid halides with 10-30 C atoms, e.g. a mixture of stearoyl chloride and sebacyl chloride, at a temperature of 400-800° F. for 1-20 hours. The additive depresses the pour point of the oil composition. It can also be used in dewaxing hydrocarbon oils.

PETROCHEMICALS

U.S.P. 2,522,687. Manufacture of Hydrocarbon Halides. F. L. Padgitt and G. F. Kirby to Ethyl Corporation.

In the manufacture of halogenated hydrocarbons, such as alkyl halides, from unsaturated acylic hydrocarbons and hydrogen halide, gallium trihalide is employed as a catalyst. The gallium trihalide may be dissolved in an inert liquid, such as ethyl chloride.

U.S.P. 2,522,752. Thiophene Acylation with Catalyst of Sulfuric Acid-Carboxylic Acid Complex. T. F. Doumani and J. F. Cuneo to Union Oil Company of California.

A thiophene with at least one hydrogen atom attached to a C atom in the ring is reacted with an acylating agent of the group of organic carboxylic acid anhydrides or ketenes in the presence of catalyst prepared by reacting conc. H_2SO_4 with more than double its molar quantity of such an acylating, at a temperature of 0-100° C. for a time sufficient to cause the disappearance of sulfate ion from the product. A thienyl ketone is obtained.

U.S.P. 2,523,490. Recovery of Lower Alkanoic Acids from Sulfonation Reaction Products. C. E. Adams and C. E. Johnson to Standard Oil Company of Indiana.

In the treatment of a hydrocarbon liquid containing mono-olefin with conc. H_2SO_4 in the presence of lower-alkanoic anhydrides or halides to form sulfonic acid derivatives of the components, the resulting oily fraction separated from the sulfuric acid fraction is contacted with 50-90 percent H_2SO_4 in a specified ratio at a suitable temperature to remove lower-alkanoic acid and unreacted alkanoic additive from the alkenesulfonic acid formed.

U.S.P. 2,523,582. Sulfonation Process. R. W. Mattson to Union Oil Company of California.

Hydrocarbon fractions, e.g. lubricating oil stocks, are contacted for sulfonation in a fine spray with a gas comprising SO_3 for a period of less than 5 seconds at a temperature not higher than 170° F.

U.S.P. 2,523,686. Catalytic Hydration of Olefins to Produce Ketones. W. F. Engel to Shell Development Company.

A mono-olefin, such as propylene, is treated with a molar excess of steam at a temperature of 200-500° C. and 10-50 atm. pressure in the presence of a catalyst prepared in a specific manner from the reduced oxides of Al, Cu, Th and Cr. The corresponding ketones, such as acetone, are produced.

Patents

U.S.P. 2,524,318. Process of Producing Larger Arylalkanes from Smaller Ones. M. S. Kharasch to Eli Lilly & Company.

Arylalkanes with not more than 12 alkane C atoms, e.g. ethylbenzene and isopropylbenzene, are treated at elevated temperature with a diacyl peroxide in which at least one of the acyl groups is an alkacyl group of not more than 4 C atoms, e.g. with diacetyl or benzoyl acetyl peroxide. Certain larger arylalkanes with a plurality of aryl groups are produced.

U.S.P. 2,524,777-8. Butadiene Methylal Addition Products. O. C. Dermer and J. J. Hawkins to Cities Service Research & Development Company.

Butadiene is reacted with a solution of methylal in conc. sulfuric acid. The reaction mixture is neutralized and steam-distilled to remove unreacted methylal and the lighter reaction products. 1,2,5-trimethoxy-3-methoxymethylpentane is recovered from the non-steam-volatile portion of the reaction products, while dimethoxypentene can be recovered from the steam distillate.

U.S.P. 2,524,970. Photochemical Preparation of Benzene Hexachlorides. M. Gonze to Solvay & Compagnie, Brussels.

Benzene hexachloride is continuously prepared by blowing chlorine gas into benzene at atmospheric pressure in the presence of light. The chlorination is started at substantially the crystallization temperature of benzene, and the operating temperature is then gradually lowered as the concentration of benzene hexachloride in benzene increases. The temperature is, however, kept above that at which benzene crystals form in this solution. The formation of secondary reaction products is inhibited by this operation.

U.S.P. 2,525,024. Process for Producing Alkyl Benzene Hydrocarbon Sulfonates. D. A. Feil to Allied Chemical & Dye Corporation.

Benzene is condensed with a halo-

Reprint Policy

A change has been made in PETROLEUM REFINER's policy with regard to small, individual orders for reprints of its articles. Since January 1 a charge of 50 cents per copy has been made WHEN REPRINTS ARE AVAILABLE. This will continue.

The charge for tear sheets of a particular article, effective April 1, has been reduced to 25 cents.

Cash or company requisitions should accompany all such "individual" orders.

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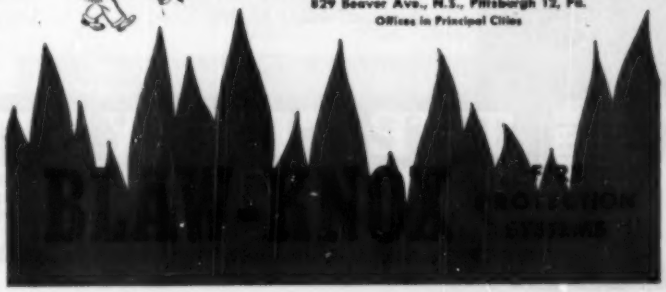
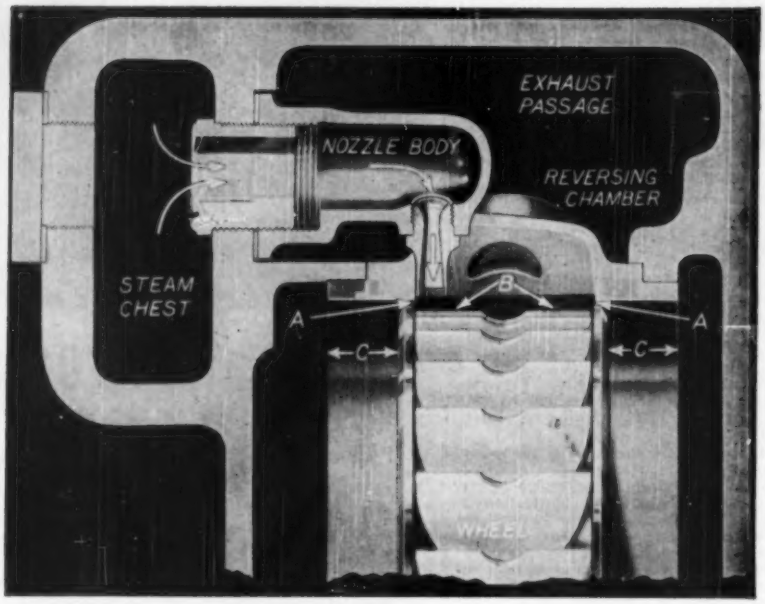


TERRY



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Note the rim clearance, AA in diagram. Also the large blade clearance, B. Side clearance, CC, is so large that end-play from external thrust cannot damage wheel.

Terry Bulletin S-116 will give you full information on the Terry Wheel Turbine. A request on your business letterhead will bring you a copy.

T-1171

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.

genated kerosine fraction of petroleum distillate or olefine derived therefrom in the presence of a condensing agent, e.g., AlCl₃. The oily layer formed on stratifying the resulting reaction mixture is further treated and finally sulfonated to produce alkyl benzene sulfonates adapted for use as detergents.

Western German Crude Runs Rise Above Prewar Output

Refinery output in Western Germany has risen 29 percent above that of the first three months of 1950 and almost 61 percent above that of the second quarter of 1949, and is now well above the prewar level. During the second quarter of this year approximately 5,103,200 barrels of crude were treated to give 5,102,550 barrels finished products.

The rise in the output of light products was attributed to the increased utilization of hydrogenation processes and additional units for production of motor fuels. The turnout of motor gasoline, which in May temporarily reached a rate of more than 595,000 barrels per month, is almost 50 percent higher than during the previous quarter and surpasses the figure for the second quarter of 1949 by nearly 68 percent. Diesel oil output rose by 52 percent as compared to the first quarter.

On the other hand, less motor and lamp kerosine was distilled, as a result of lower demand and uncertainty about price. During the same period, lube production was 23 percent above that of the first three months of 1950. This increase is largely represented by spindle oil, motor oil, transformer oil and axle oil. Production of bitumen also continued to rise.

Following is a breakdown of refinery output in Western Germany during the first half of 1950, in barrels:

Product	Barrels
Liquid Gas	166,190
Motor gasoline	2,548,060
Special benzine	472,250
Lamp kerosine	262,590
Motor kerosine	75,870
Diesel oil	1,516,950
Lubricants	1,610,070
Bitumen (asphalt)	980,732
Fuel oil	1,094,960
Other products	67,520

Lest Fills Director's Post With Interstate Pipe Line

Charles Lest, assistant general manager of the Baton Rouge, La., refinery of the Esso Standard Oil Company, has been elected a director of Interstate Oil Pipe Line Company. He fills the post vacated by the resignation of Cecil Morgan, vice president of Esso Standard in charge of Louisiana manufacturing operations and crude oil purchasing.

Scholarships Planned

Lion Oil Company has established the Lion Oil scholarship fund, from which six one-year scholarships, each valued at $1000, and one three-year scholarship worth $3000 will be distributed to Southern high school students through a series of essay contests.

Take a hint from the many Refineries of all sizes using National Sections in Condenser and Cooler service. Replacement of old-fashioned pipe coils with National Sections in submerged type applications has sharply improved overall output at no increase in box size, and at surprisingly modest cost. And, maintenance problems are minimized by the long life and proven excellence of the fine-grained cast iron in National Sections. Let National Sections solve your tough water problems.

Special Note to Users of Older Types of Sections with External Fins:

The smooth outer surface of National Sections provides greater resistance to scale formation and collection of other foreign matter. The absence of lugs or fins to act as focal points from which these accumulations build upon insulating layer means less frequent cleaning, less maintenance, longer life and better performance.

Heat Transfer Division

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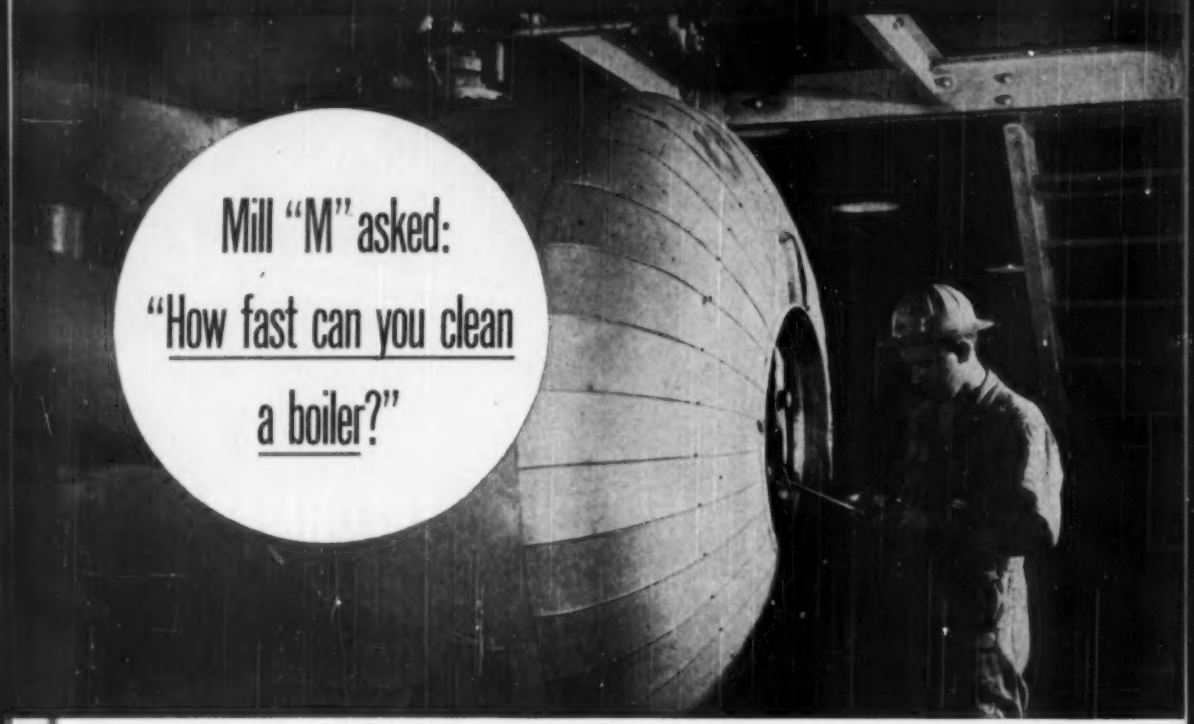

Dowell Service cleaned the internal surfaces in 10 hours!

This was the case of a boiler generating 350,000 pounds of steam per hour with an operating pressure of 1250 p.s.i. In ten hours Dowell Service removed an estimated 1,000 lbs. of deposits which were causing tube failures. The boiler was back on the line the next day.

What is Dowell Service? It is simply the application of chemistry to the problem of removing deposits from heat exchangers, water lines and all kinds of process equipment. Dowell engineers fill the equipment with liquid solvents which reach wherever steam and water flow and are designed to dissolve and disintegrate the deposits efficiently and quickly. Dismantling is not necessary.

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Entire Piping Systems of two college dormitories cleaned of scale.

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Three Formaldehyde Contact Towers and Reboilers cleaned and restored to designed operating efficiency.

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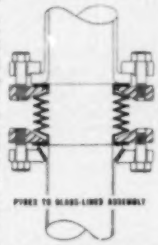
Expansion Joints

1 For use where thermal expansion, vibration, misalignment or other conditions demand a flexible, chemical-proof piping section, "Chemiseal" Teflon expansion joints are made by Teflon Products Division, United States Gasket Company, P. O. Box 93, Camden, N. J. They are designed for 25 pounds pressure and are serviceable throughout the temperature range from —150° F. to 400° F. Available for all types of equipment and for a wide variety of operating conditions, the expansion joints are normally supplied with suitable integrally-gasketed flanges drilled to 150 pounds ASME standard. Catalog 212.



Piping System

2 A new pulsation dampening system, offered by The Fluor Corporation, Ltd., 2500 South Atlantic Boulevard, Los Angeles 22, is a complete compressor piping system which attenuates objectionable peak pressures caused by the reciprocating action of compressors to permit a smooth, steady flow of compressed gas through the system. Design and engineering of the system is predicted upon bottles, laterals and headers being scientifically related to provide the appropriate components of acoustical filters, the basic principle of the Fluor "package-type" pulsation dampener. Bulletin PDS-8501.

Packings and Gaskets

3 The Garlock Packing Company, Palmyra, N. Y., has announced packings and gasketing materials made of "Teflon," a tetrafluoroethylene resin. The new packings are unaffected by acid and are highly resistant to all organic solvents and alkalies. They operate at temperatures from below —90° F. up to 500° F. and have high mechanical strength and a low coefficient of friction within that temperature range. A catalog published by the company describes the types of braided and molded packings, the gaskets encased in "Teflon," and the gaskets made of solid "Teflon."

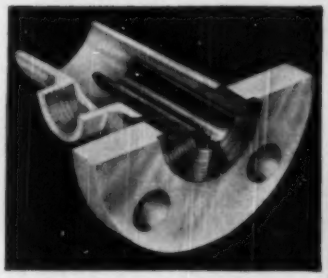
Dry Chemical Engine

4 A new giant-size dry chemical wheeled portable engine, "Alfco 35," for extinguishing inflammable liquid and electrical industrial fires has been announced by American-La-France-Foamite Corporation, Elmira, N. Y. Despite its large size, the engine can be handled by two men. A range of from 20 to 25 feet, plus the insulating effect of the density of the dispersion of its sustained pressurized discharge, makes it possible for the operator to move up quickly to the fire with the full force of the discharge. The tank of the engine contains 350 pounds of Alfco Dry Chemical, which can, if necessary, be discharged in one minute and 15 seconds. Expellent is dry nitrogen with a sustained operating pressure of 200 psi. during the entire period of discharge.

Noise Abating Equipment

5 Burgess-Manning Company, Libertyville, Ill., has developed noise abating and safety equipment, designed for engines using natural gas as fuel. The new snubbers decrease noise from exhausts of internal combustion engines and can also be used to reduce hazards of fire and explosion. They can be used with or without "fog jet" which sprays a cooling mist of water vapor on the exhaust entering the snubber. Flame from the engine is cooled and extinguished while gas is made non-inflammable by the water fog. Sizes range from 49 to 7275 pounds.

Heat Exchanger



6 A new corrosion-resistant heat exchanger, "Econalloy" is made by Martin-Quaid Company, 1876 Sedgley Avenue, Philadelphia 32. Corrosion-resistant materials are used only where required and a corrosion-resistant joint is made without welding to the inner tube. The exchanger forms an integral part of the piping system and can be supported vertically or horizontally along a wall or on hangers. It is available in sizes from a fraction

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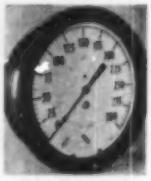
of a square foot of heating surface to several hundred square feet in lengths up to 30 feet per segment. Internal tube sizes range from ¼ to 4 inches, and units are available for pressure up to 900 psi. and temperatures in excess of 700° F. Bulletin 9-1.

Temperature Indicators

7 A new line of thermocouple actuated Microsen Temperature Indicators and Recorders by Manning, Maxwell & Moore, Inc., Bridgeport 2, Conn., is introduced in Bulletin 404 of the company. The new electrical instruments are capable of measuring temperature between minus 100° F. and plus 3000° F. Their power actuation and construction simplicity supplants the delicate construction of millivolt pyrometers and eliminates the need for slidewires, standard cells, delicate moving contacts or complicated mechanisms.

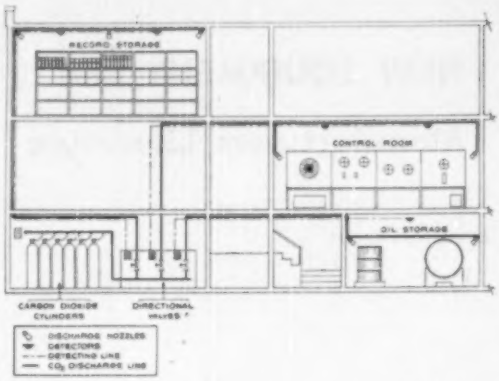


Temperature Controller

8 A bulletin by Taylor Instrument Companies, 95 Ames Street, Rochester, N. Y., discusses the company's new Transet Tri-Act Controller. The pneumatic circuit is based on a two-stage plan, employing the pre-act response in the first stage which feeds the reset and proportional responses in the second stage. This has been done to compensate for any lag, and thus improve liquid flow, pressure and cascade control systems.

Fire Protection

9 Through the use of directional valves, Walter Kidde & Company, 40 East 34th Street, New York 16, has developed a fire protection system to protect several hazard areas with a single source of extinguishing agent. As many as 25 separate hazard spaces may be protected with one carbon dioxide cylinder bank. The supply source of the Multi-Space Fire Guard System comprises storage cylinder manifolded together for simultaneous discharge. From the cylinder bank, the carbon dioxide discharge pipe line connects to a directional valve frame, where there is a valve for each hazard space protected. From the directional valve frame, a carbon dioxide discharge line and a fire detector connecting line goes to each hazard area. Within each protected area are one or more fire detectors and a network of Multijet discharge nozzles. When the detector picks up the first signal of fire, mechanical reactions cause the carbon dioxide to rush through the piping to the space in danger, where it expands to 450 times its stored volume.



Temperature Measurement

10 A new manual by The Partlow Corp. of New Hartford, N. Y., sets down the basic principles of industrial temperature control. Entitled, "The Design and Process Engineers Guide to Industrial Temperature Measurement and Control," the study defines the types of control systems and distinguishes between them so that the process engineer, plant manager, design engineer and heating engineer can select the type to fit his situation. First described are the eight ways of responding to temperature, the five ways of putting that response to work and the nine basic Partlow instrument types. Several chapters are given to problems that plague the heating engineer.

Anti-Corrosion Coating

11 A one-coat, self-protecting, anti-corrosion coating is described in technical Bulletin 100, published by Industrial Metal Protectives, Inc., 401 Homestead Avenue, Dayton 8, Ohio. The bulletin presents case histories on companies and typical applications; complete specifications for the two Zincilate formulations; data on surface preparation and methods of application; and an offer of providing process engineers to investigate corrosion problems and supervise applications.

Silicone-Insulated Welder

12 A new silicone-insulated, portable a-c welder, equipped with automatic "Hot Start" control has been announced by the Welding divisions of General Electric's Apparatus department. Known as 6WK30J series, it is one of the first standard a-c welder lines commercially available incorporating silicone insulation, which is unaffected by high temperatures and is

Want More Data?

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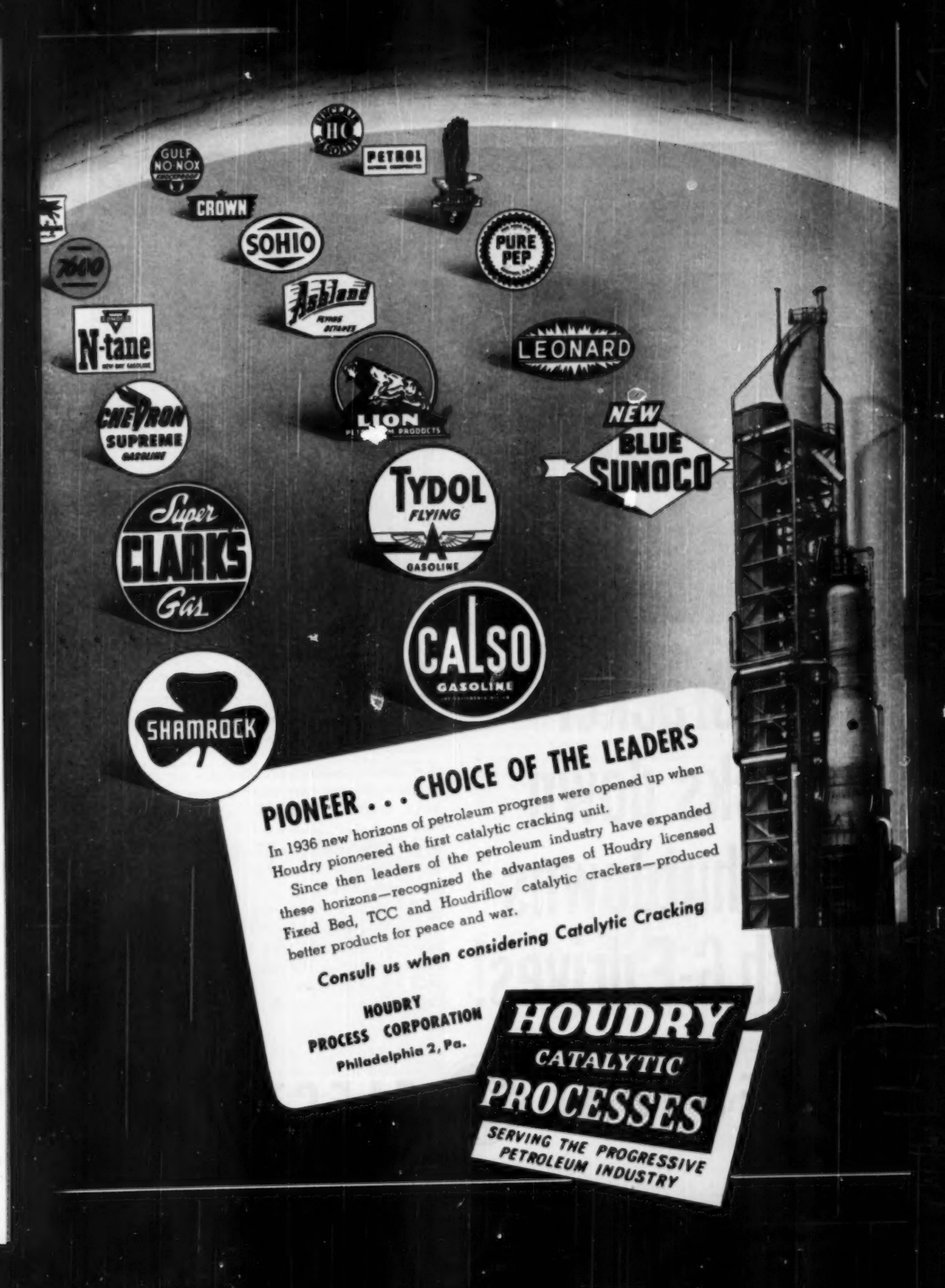

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In 1936 new horizons of petroleum progress were opened up when Houdry pioneered the first catalytic cracking unit.

Since then leaders of the petroleum industry have expanded these horizons—recognized the advantages of Houdry licensed Fixed Bed, TCC and Houdriflow catalytic crackers—produced better products for peace and war.

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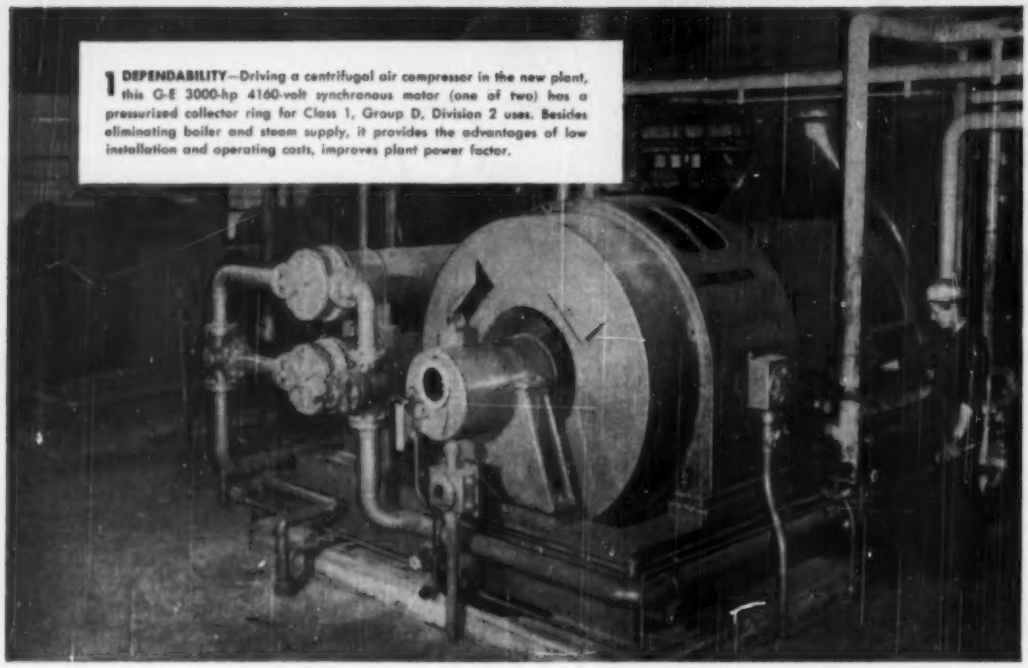


1 DEPENDABILITY—Driving a centrifugal air compressor in the new plant, this G-E 3000-hp 4160-volt synchronous motor (one of two) has a pressurized collector ring for Class 1, Group D, Division 2 uses. Besides eliminating boiler and steam supply, it provides the advantages of low installation and operating costs, improves plant power factor.

Cat Cracker cracks down on shutdowns with G-E drives!

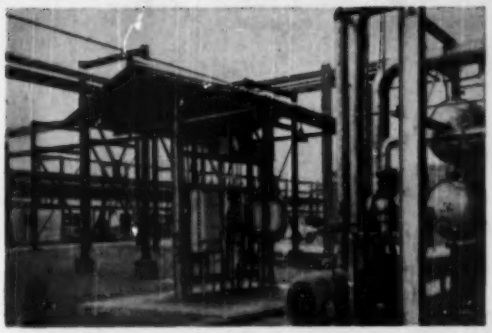
Sohio's new $11,000,000 fluid catalytic cracking plant at Lima refinery goes on stream—with co-ordinated G-E equipment helping to maintain continuous, 16,000-bbl-per-day rate!

Fluid catalytic cracking—operating as it does on a continuous basis—just can't afford shutdowns of motor-driven equipment. That's why, at Sohio's new Lima plant, the natural choice was G-E motors and control. Carefully co-ordinated to work together and stay on the job, they minimize costly plant downtime, help keep output continuous!

Whatever your process needs, G.E. can match them from the most complete line of electric equipment made for refinery service, with G-E engineers to help apply it most economically. Ask your nearest G-E office about it—*early* in your planning. *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*

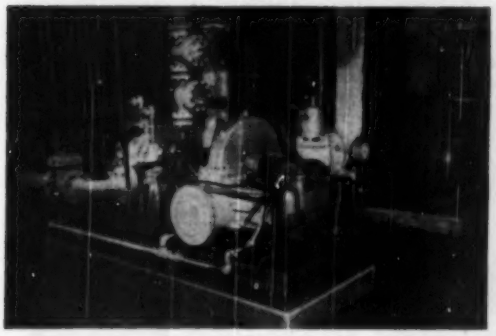
GENERAL ELECTRIC

661-23

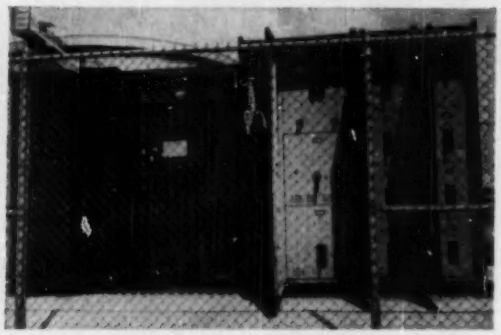


2 CONVENIENCE—A practical way to install low-voltage control in hazardous areas is to rack up an assembly of G-E combination starters and breakers, as shown here, for indoor or outdoor refinery use. They can be located close to the motors, as in this Class 1, Group D application at Sohio's new catalytic cracking plant.

3 JOB-RIGHT—Here, 7 of 14 G-E 100-hp vertical motors drive pumps that recirculate cooling-tower water. Both the motors and the G-E push-buttons mounted behind the middle motor are explosion-proof for Class 1, Group D use. G-E control for hazardous areas includes both air-break and oil-immersed types to match all G-E explosion-proof motors.



4 SELF-PROTECTED—In the pump house, this G-E Type DP mechanical drive turbine provides reliable adjustable-speed drive. Completely interchangeable spare parts plus new, standard pressure-lubrication system make these units—which operate anywhere in damp, hot, or hazardous areas—ideal for your toughest refinery applications.



5 LOW-COST POWER—In the new plant's tank field, a non-hazardous location, this G-E 750-kva outdoor load-center unit substation steps down 4160-volt power to 480 volts for use right where it's needed. These easily installed G-E units eliminate voltage drop for higher operating efficiency, cut power losses, provide flexibility for growth.

6 CENTRALIZED CONTROL—Motors driving much of the equipment on Sohio's catalytic cracking unit are controlled from a non-hazardous area, in this case the switch house, containing G-E low-voltage switchgear (left) and G-E Cabinetrol (extreme right). Made in compact, standardized units, they provide maximum personnel safety and flexibility of arrangement.

Co-ordinated
ELECTRIC EQUIPMENT
for Fluid Catalytic Cracking

New Equipment

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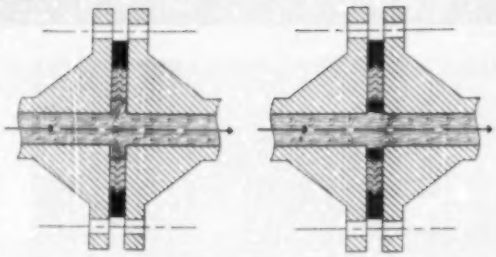
water repellent. Instant arc striking without manual adjustment is provided by "Hot Start" automatic control. The ampere range is covered by three overlapping current ranges which permit precise current control, reducing idling current. The welder, 17 inches in diameter and 35 inches high, weighs 325 pounds and has a current range from 40 to 375 amperes. It accommodates electrodes from 3/32 to ¼ inch diameter. Mounted on a running gear, the welder can be moved when required.

Address, Schenectady, N. Y.

High-Pressure Gasket

13 A new high-pressure gasket by Flexitallic Gasket Company of Camden, N. J., was designed to streamline jointed connections, reduce turbulence in the piping and increase flow of fluid. The new gasket, Style CGI, is a compression gauge type with an inside and an outside ring. It has a spiral-wound construction with alternating V-crimped plies of metal and filler. The inside ring converts one of a pair of smooth face flanges to a groove flange, providing the safety of a wholly contained gasket. The inside ring also provides a compression gauge which supplements the outside ring. It prevents radial movement of the gasket under extremely high bolt loads and minimizes gasket contamination from highly corrosive fluids. Pressure range of the new gasket, which is made for practically all standard ASA and API fittings as well as special design, is 150 to 2500 pounds. The illustration, left, shows turbulence in flanged joint when sealed with conventional gasket. Drawing at right shows effect on the new gasket, reducing turbulence and increasing flow.



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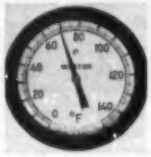
Thermometer Adaptation

14 An adaptation of the Model 2221 Weston all metal thermometer has been accepted by the ASTM as an alternate to mercury-glass angle stem thermometers, it was announced by Weston Electrical Instrument Corporation, 617 Freling-huysen Avenue, Newark 5, N. J. Developed to overcome the breakage problem encountered with glass thermometers, the instruments fit the sockets already incorporated in many pressurized storage tanks used throughout the petroleum industry. The new thermometer covers a range from 0 to 150° F., with the scale marked in 1° divisions. The instrument has a dial five inches in diameter and a stem three feet long, with the measuring element in the first two inches.



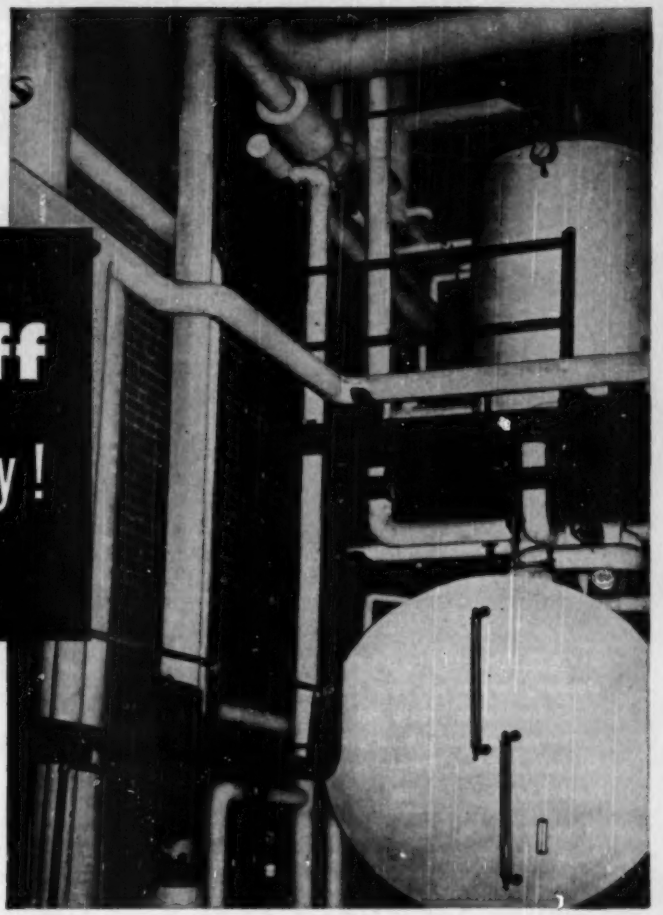
Vapor Purifier Manual

15 A vapor purifier engineering manual complete with tables and formulas for easy selection of correct purifier sizes has been announced by The Centrifix Corporation, 3614 Payne Avenue, Cleveland 14, Ohio. Designed for engineers who must select equipment to solve entrainment problems in vapor, steam, gas and air application, the manual provides information to apply to internal purifiers for drum, evaporator, receiver and line units used in branch line applications.

Centrifugal Sand Pump

16 A. R. Wilfley and Sons, Inc., of Denver is manufacturing a new Model "K" heavy duty centrifugal sand pump with two-piece frame con-

Insulation Contractor
Guy M. Beaty & Co.
Charlotte, N. C.



Hot stuff kept that way!

How United States Plywood Corporation conserves steam—cuts heating costs—with K & M "Featherweight"® 85% Magnesia Insulation

The production of the United States Plywood Corporation's famous *Craftsman's grade* of Weldwood Plywood calls for steam - and plenty of it. In the photo above, you see the Deaerating Feed Water Heater and the Condensate Tank in U.S. Plywood's Orangeburg, S.C., plant. And you can see how K&M "Featherweight" 85% Magnesia Insulation has been applied to these heating units, as well as to the lead lines and pipes of the steam system. Throughout this entire plant, "Featherweight" 85% Magnesia is on the job conserving steam in lines and equipment; keeping heating costs down.

K&M "Featherweight" Insulation has been doing jobs like this for more than 60 years—under every conceivable installation condition. In factories, power plants, oil refineries, chemical plants, hospitals, steamships—wherever exacting steam temperatures must be maintained—you'll find "Featherweight" 85% Magnesia.

This highly efficient insulation combines basic carbonate of magnesia with asbestos fibers—is light-weight, strong, fire-proof—time-proved for all steam temperatures up to 600°F. Ask your local Keasbey & Mattison Distributor for complete information; or, write us direct.

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New Equipment

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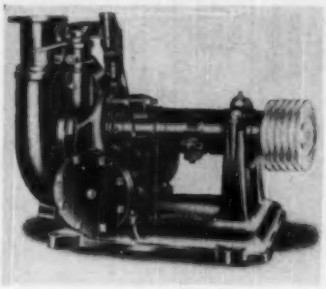
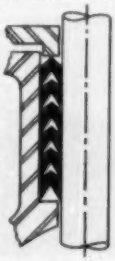


struction. This permits the rubber-lined or special-alloy intake chamber to be replaced. A check valve eliminates leakage. The pump is available in direct connected, belt-driven and overhead V-belt driven types in 1, 1½, 2, 2½, 3, 4, 5, 6 and 8-inch discharge. Rubber covered wear parts are available for all sizes and are interchangeable with the hard iron parts.

V-Type Teflon Packing

17 A V-type Teflon packing, Chemiseal 810V, was designed to give solid Teflon unusual mechanical resiliency, permitting a tight seal at low gland pressure. Manufactured by Teflon Products Division, United States Gasket Company, P. O. Box 93, Camden, N. J., the packing is chemically inert, heat-resistant, antihesive, and tough. Light gland loading, plus natural slipperiness, reduces the torque required to operate the valve, and the new packing will not "freeze" a valve no matter how long it remains unoperated. It is available as a series of V-shaped rings, which act as a wedge under compression in the stuffing box. This forces the lips of the next ring tightly against spindle and stuffing box, thus the sealing action does not depend entirely on deformation. Catalog 810V.

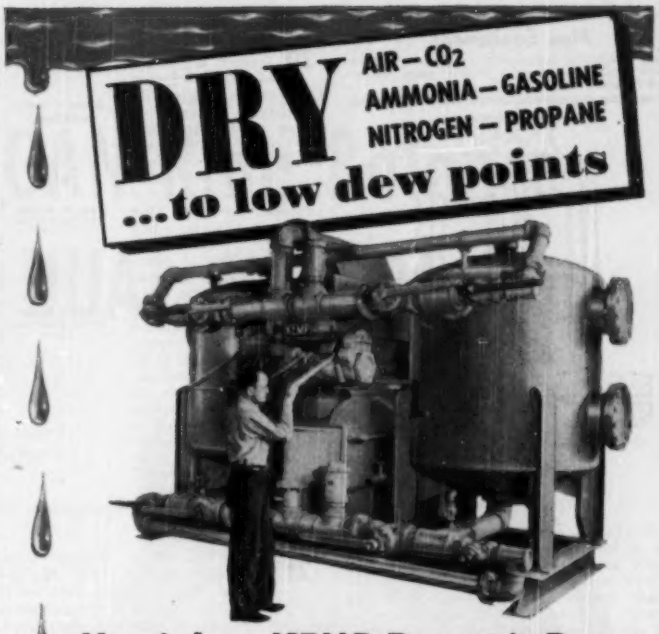


Steam Traps

18 Super-Silvertop Steam Traps are described in Bulletin 550 of V. D. Anderson Company, 1935 West 96th Street, Cleveland 2. The bulletin contains specifications, capacities, sizes, pressures, weights and list prices of all principle types of these steam traps. Data is also contained on the company's self-cleaning strainers and steel series steam traps.

Small Steam Traps

19 New small forged steel steam traps have been developed by V. D. Anderson Company, 1935 West 96th Street, Cleveland, for high pressure, super-heated steam service. These traps are suitable for steam pressures up to 500 pounds with 800°



Here's how KEMP Dynamic Dryers remove moisture from air, gases or liquids, for as little as ¼c per mcf!

IF YOU think drying air, gases or liquids cost too much—find out how Kemp can save you money! Hundreds of Kemp Dynamic Dryers *control moisture at low cost* in plants all over the country. Operation is guaranteed to your specifications and the cost is surprisingly low. Many Kemp users report drying to *sub-zero* dew points for as little as ¼c *per mcf*—including all charges for labor, capital investment and materials!

FLEXIBLE DESIGN

Kemp Dynamic Dryers are versatile—offer *manual, semi-automatic* or *automatic* operation. Desiccant is especially selected and compounded for the type drying your problem calls for. With Kemp you can dry *air, gases* or *liquids, control humidity* in large or small areas, or *eliminate moisture* in materials. Gas, electric or steam regeneration is supplied as standard equipment.

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Whether your moisture control problem is special or standard, you'll find Kemp has a Dynamic Dryer especially designed to solve it. Find out how Kemp engineering can save you money. Get the facts. Bulletin D-27 contains specifications, technical data and full information. For your free copy, mail coupon today!

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New Equipment

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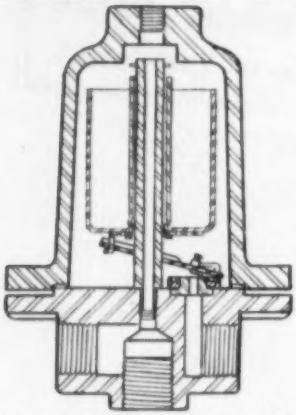
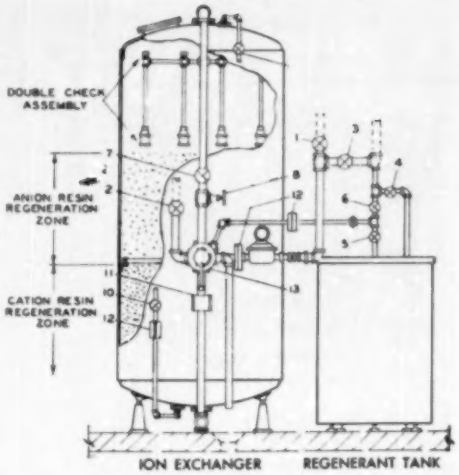


total temperature and have ½ inch or ¾ inch pipe connections. Head and body are of forged steel to withstand shock and explosions. The traps are made in two principle types. No. 340, shown, is installed straight-in-line or as an elbow eliminating nipples and fittings. The other type, No. 60, is designed with the inlet in the bottom and the outlet connection in the top for a vertical installation.

Water Deionizer

20 A single tank deionizer, a product of Elgin Softener Corporation, Elgin, Ill., produces mineral-free water at a price that will bring such water into the range of those who have found evaporated or distilled water prohibitive in cost. This deionizer removes silica and carbon dioxide from water, making it practical for steam generation. The specific electrical resistance of such water is above 5 million ohms. The deionizer, which uses a single tank, has a manifold arrangement which guards against loss of zeolite during the backwashing operation and permits the use of deeper zeolite beds for increased capacity.

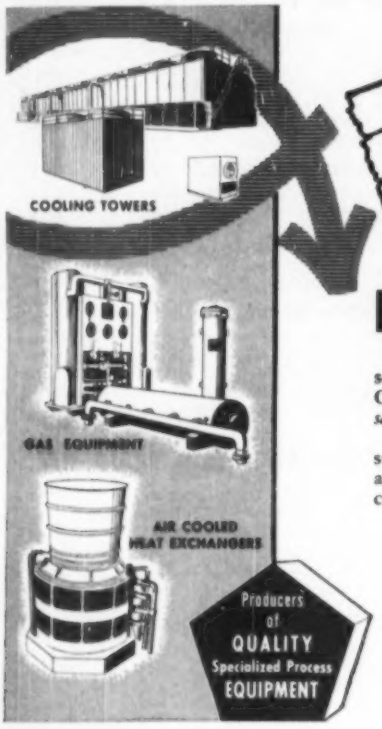


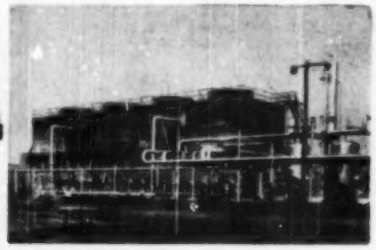
Alloy Steel Tubing

21 The Babcock & Wilcox Tube Company, Beaver Falls, Pa., offers a new technical data card, TDC 136, on the chemical compositions of the company's seamless alloy steel tubing, specifically B&W Croloy steels of the low and intermediate alloy groups. These apply to pipe for high-temperature service and tubing for use in heat exchangers, condensers, refinery stills, boilers and superheaters. Data cover carbon, manganese, phosphorus, sulfur, silicon, chromium and molybdenum content, according to ASTM specifications.

Miniature Ion Exchanger

22 A new refillable ion exchange unit by LaMotte Chemical Products Company, Towson, Baltimore 4, fastens to an ordinary faucet to give





with Pritchard

INDUSTRIAL COOLING TOWERS

Wherever you see a Pritchard Cooling Tower, you see water conservation at work! In dissipating heat to the atmosphere, Pritchard Cooling Towers assure you greater efficiency and economy... *plus water savings up to 99% over former wasteful methods.*

Pritchard Towers are adequately sized, thoroughly engineered, constructed of highest quality materials...and guaranteed to meet your peak as well as normal load requirements. For the solution to your water conservation problem, consult your nearby Pritchard representative.

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J.F. Pritchard & Co.
Dept. No. 81 908 Grand Ave., Kansas City 6, Mo.

District Offices: Houston • St. Louis • Chicago • Pittsburgh • Tulsa • New York
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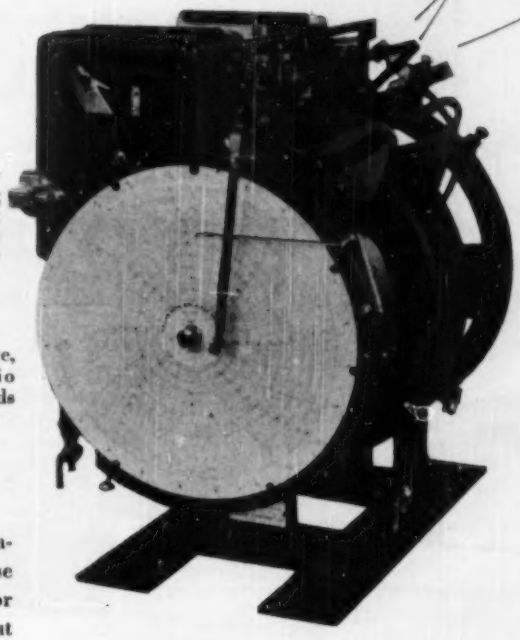
HAGAN Ring Balance DUAL METERS

1 Require *no more panel space* than single meters.

2 Measure any two flows or flow and specific gravity recording them on the same chart for quick comparison. Either or both flows may be automatically totalized by built-in integrators.

3 By means of additive, subtractive or ratio linkage, combine records as desired.



In every power plant there are applications where some of the features of these versatile meters are highly important. For full information concerning them, fill out the coupon below, or write to Hagan Corporation, Hagan Building, Pittsburgh 30, Pennsylvania.

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RING BALANCE FLOW AND PRESSURE INSTRUMENTS
THRUSTOR FORCE MEASURING DEVICES
BOILER COMBUSTION CONTROL SYSTEMS
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Hagan Corporation
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Pittsburgh 30, Pa.

Please send me your bulletin "Hagan Ring Balance Dual Meters."

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PR 12

TO *Reduce* YOUR SLURRY PUMPING *Costs*

SPECIFY

Pacific

Precision Built

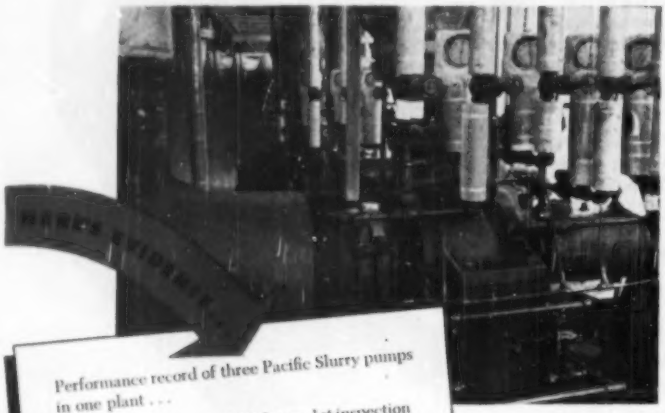
SLURRY PUMPS

1 Pacific's special design provides maximum protection for wearing rings, shaft sleeves and packing.

2 Precision workmanship insures the perfect fit necessary to prevent destructive cutting of parts caused by leakage from high to low pressure areas.

3 All parts are fabricated from materials selected for strength, toughness and resistance to erosion and corrosion.

A combination that decreases frequency of down time, decreases frequency of parts renewal and decreases maintenance cost.



Performance record of three Pacific Slurry pumps in one plant . . .

1st run—on stream . .	270 days	—1st inspection
2nd run—on stream . .	420 days	—no inspection
3rd run—on stream . .	420 days	
Total On Stream . .	1110 days	—2nd inspection

1st inspection made on 1 pump only. No parts were replaced as the condition of the pump was perfect.

On the 2nd inspection each pump was examined. Wearing rings and shaft sleeves were replaced in all 3 pumps and the impeller in one.

Exceptional Performance? No . . . just average!

Write for Bulletin 86A

PB-10

Pacific Pumps inc.

HUNTINGTON PARK, CALIFORNIA

Export Office: Chanin Bldg., 122 E. 42nd St., New York

Offices in All Principal Cities

PACIFIC *Precision Built* PUMPS

New Equipment

(For additional information or literature check item numbers on mailing coupon, page 175, or write manufacturer direct.)

deionized water. Called the Filtr-Ion, it is a small, low-cost application of the Monobed ion exchange principle and was designed for use where more elaborate equipment would be impractical. The unit is a transparent plastic tube, 8½ inches long and 1⅝ inches in diameter, filled with Amberlite ion exchange resins which change color when exhausted. The deionized water is delivered through a small plastic tube.

Motor-Generator Booklet

23 A booklet on synchronous motor-generator sets has been published by General Electric Company, Schenectady 5, N. Y. Designated as GEA-5506, the publication covers sets from 30 to 800 kw. as a source of d.c. power for many industrial applications, such as rolling-mill motors and other drives, electrolytic refining of ores, excitation for synchronous and d.c. motors and generators, motion picture lighting, mining and quarrying, wind tunnels and other large testing equipments, and general purpose use.

Torch Welding

24 "How to Weld with Heliarc Torches," is a revised booklet containing information on welding, surfacing, and hard-facing of many commercially used metals. As Booklet F-6190, it is published by The Linde Air Products Company, 30 East 42nd Street, New York 17, N. Y.

Gradient Depth Hardening

25 Simple procedure for real gradient depth hardening of large or small machine parts by the Wilson Process is described in new Bulletin 13 by Wilson Carbon Company, Inc., 60 East 42nd Street, New York 17. It shows how any kind of steel can be gradient depth hardened with a positive change in grain structure from the steel's surface through the ductile area and clear through the core.

Rotary-Vane Air Motor

26 Gast Manufacturing Corporation's (Benton Harbor, Mich.) new No. 8 rotary-vane air motor offers the advantage of variable-speed drive with simple valve control, explosion-proof

99%

CATALYST RECOVERY?

Research Corp. Engineer: Yes sir. Actual operating experience with our Cottrell precipitators shows recoveries as high as 99.6% of fluid catalyst.

Refinery Executive: What about draft loss?

Research Corp. Engineer: It's extremely low —only a few tenths of an inch of water.

Refinery Executive: Do you actually guarantee performance?

Research Corp. Engineer: Absolutely. And you can depend on a Research Corporation guarantee because of Research Corporation's 38 years experience in electrical precipitation.

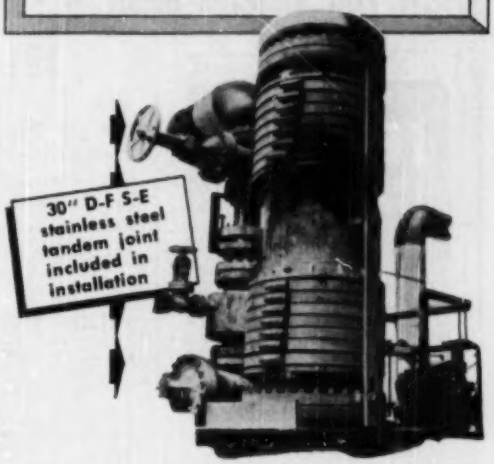
BC 130

RESEARCH CORPORATION

405 Lexington Avenue, New York 17, N. Y.
122 South Michigan Avenue, Chicago 3, Illinois

FOR ITS NEW TOLEDO REFINERY

SUN OIL CHOOSES Badger EXPANSION JOINTS



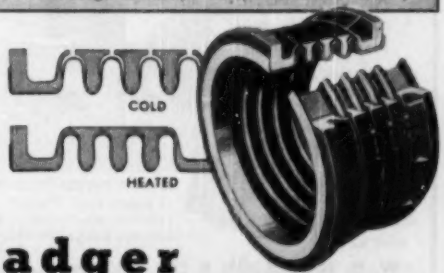
When Sun Oil Co. builds a refinery, only the best equipment is good enough. So it's no surprise to see Badger Expansion Joints at the new Toledo refinery of this giant of the petroleum industry.

The Badger Tandem Joint shown is one of several used in this installation to protect piping and equipment from damage due to both axial and lateral movements at high temperature. It is built to the famous Badger Directed-Flexing Self-Equalizing design . . . an exclusive feature that equalizes stresses between and within corrugations . . . multiplies efficiency and joint life.

Like hundreds of others, Sun Oil Co. knows from experience that these extra features in Badger Joints will keep their maintenance costs at a minimum:

- Packless . . . pressure-tight single tube
- Special forming . . . no structure-weakening stresses
- Controlled heat treating . . . assures long life
- Directed-flexing — all-curve flexing motion
- Fabricated from stainless steel or alloys for high pressure, temperature and corrosion, or from copper for normal use

Find out how Badger can save you money — write for facts today.



Badger
MANUFACTURING COMPANY
230-260 BENT STREET, CAMBRIDGE, MASS.

MONEL MESH by JELLIFF

Even though your filters did not ★
have JELLIFF MESH as original ★
equipment, you can still ★
bring them "up to snuff." ★

WHEN YOU REPLACE MESH • • REPLACE WITH

JELLIFF'S

THE C. O. JELLIFF MANUFACTURING CORPORATION SOUTHPORT, CONN.

Not only Monel, either. Any ductile metal inert to your process—any mesh up to 200 x 200 or 50 x 750—in any suitable weave—and cut to size and shape per your blueprints, ready to slip into place for a long, useful, low-cost life.

WHEN YOU SPECIFY MESH . . . SPECIFY *JELLIFF'S*

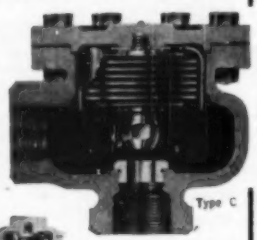
Write Department 16

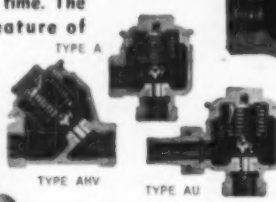
Nicholson Makes

Freeze-Proof Steam Traps

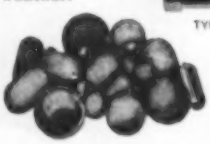
for Every Plant Use

Because they drain completely when cold, these four types of Nicholson steam traps are positively freeze-proof. Can be freely installed outdoors. Universally recommended for use in lines which need not be in continuous use during cold weather, because they are freeze-proof and because their 2 to 6 times average drainage capacity results in minimum heat-up time. The non-air-binding feature of Nicholson traps also notably facilitates steam transfer in severe weather.





Four types: size ¼" to 2"; press. to 225 lbs. BULLETIN 450.

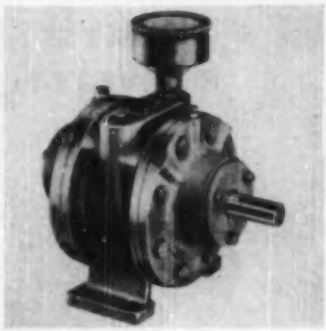


HIGH-PRESSURE FLOATS—Stainless, monel, steel or plated steel. Welded. In all sizes and shapes; for operating mechanisms and as tanks or vessels. 2-day delivery. BULLETIN 650.

W. H. NICHOLSON & CO., 207 Oregon St., Wilkes-Barre, Pa.

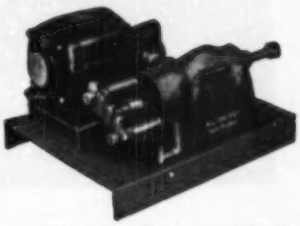
New Equipment

(For additional information or literature check item numbers on mailing coupon, page 175, or write manufacturer direct.)



safety in hazardous location, and proof against damage when slow or stalled by overloads. Operating range is from ½ hp. at 500 rpm. to 3 hp. at 1500 rpm. for the reversible type. Non reversible models deliver up to 4 hp. Bulletin AM-860 describing this new motor has been published by the manufacturer.

Controlled Volume Pump



27 Milton Roy Company, 1300 East Mermaid Lane, Philadelphia 18, has developed a controlled volume pump that will handle liquids in the cubic centimeter per hour range with metered accuracy. "MiniPump" as it has been designated, has a range of 3 cc. to 800 cc. per hour, with operating pressure up to 1000 psi. Intended for handling clear liquids, the pump has application for automatic titration, proportional blending of two or more liquid streams, continuous sampling, injecting odorants into gases, and for handling inhibitor compounds in petroleum operations. It is described in Bulletin MP-50.

Scaffolding

28 Steel tubular scaffolding, offered by Adjustomatic Scaffolds Company, 1260 Hodiamont Avenue, St. Louis 12, is described in two new catalogs. Designed for quick construction, the scaffolding has a positive locking device which requires no bolts, wing nuts, coupling pins, tools or ladders.

Electro Dynamic Shaker

29 A new piece of vibration test equipment has been added to the line of The Calidyne Company, 751 Main Street, Winchester, Mass. "Model 44 Shaker" with 50 g. acceleration, hitherto unobtainable by force shaking, has mass loads of ¾ pound or

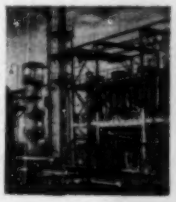
A strange breed of "cat" ... cat-equipment, that is!

ONE of the unusual types of equipment Kellogg is frequently called upon to fabricate is the cat-poly reactor. A strange breed of heat exchanger, it is in reality a combination pressure vessel and heat exchanger, inasmuch as operating pressures in the catalyst-packed tubes reach 1200 psi. Another unusual aspect of these exchanger-vessels is that they are designed to be taken out of service regularly for replacement of catalyst, rather than being built to operate without maintenance for as long a period as possible.

Fabrication of this type of equipment is unusual, too, in the heat exchange field. First, it's on the "grand" scale, tubes being 5 inches in diameter and 40 feet long, and the shells 50 inches in diameter. But probably the most important single fabrication step is *the welding of the tubes to the tube sheets*, replacing the customary roll-in operation. Here Kellogg's unusually broad experience in welding techniques asserts its importance... guarantees the customer finished cat-poly reactors in the minimum time with the maximum service life built in.

One recent order!

An even dozen Kellogg cat-poly reactors are installed in this brand new East Coast refinery. Another three-quarter dozen are now being finished in Kellogg shops, destined for a Midwest plant operated by the same refiner.



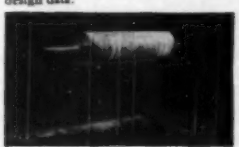
Continuing Basic Study of the principles of heat exchange conducted by Kellogg development groups for more than twenty years has produced unduplicated design data.

Shop Layout Craftsmen are fully experienced on all types of heat exchanger fabrication from gigantic marine condensers to intricate jet motor combustion-chamber shells.

To matter temperature, pressure and chemicals use

M. W. KELLOGG

process equipment



Extensive Shop Facilities, including every necessary fabricating step from plate rolling to stud threading, permit *complete* fabrication under same roof of any type of heat exchanger for any kind of service.

Special Shop Techniques permit the economical fabrication of the component parts for each heat exchanger as an individual production order and provide every exchanger with the advantages of "tailor-made" fit and serviceability.

Rigid Quality Control maintained by inspectors reporting directly to *Shop Management* rather than to *Production* executives, maintains quality of work at a much higher level than could be attained by customary control methods.

Heat Exchangers
Process Piping
Bonus and Headers
Giant One-Piece Bends
Pressure Vessels
Vacuum Vessels
Fractionating Columns
Drums and Shells

★

The M. W. Kellogg Company (Subsidiary of Pullman, Incorporated)—Offices in New York, Jersey City, Buffalo, Los Angeles, Tulsa, Houston, Toronto, London and Paris

New Equipment

(For additional information or literature check item numbers on mailing coupon, page 175, or write manufacturer direct.)

less. Testing to U. S. Air Forces specifications of 20 g. can be met with inertia loads up to 14 pounds. Bulletin 4401.

SK Products List Folder

30 Schutte and Koerting Company's new products folder, "Index of SK Equipment and Descriptive Bulletins" lists SK products according to application and alphabetically, together with the numbered descriptive bulletin pertaining to each product.

Address Thompson and 12th, Philadelphia.

How to Select a Cooling Water Service

First, look for a service based on sound engineering practice—one that is experienced in the solution of individual cooling water problems.

Second, look for a service which has a proven record of eliminating corrosion, scale, and biological fouling—at a cost that is not excessive.

Finally, look for a service which is backed by an organization with ample facilities to extend prompt assistance when and if special problems or emergencies arise.

For over two decades BETZ has provided engineering guidance and developed control procedures for the correction and prevention of industrial water difficulties. If the results you are presently obtaining are not fully satisfactory, our nationwide staff of engineers welcome the opportunity to discuss your water problems. W. H. & L. D. BETZ, Gillingham & Worth Streets, Philadelphia 24, Pa.

BETZ

COOLING WATER CONDITIONING • BOILER WATER CONDITIONING

Packings Catalog

31 A new illustrated catalog, just issued by Greene, Tweed & Company, North Wales, Pa., brings together all material on the Palmetto packings previously made available in separate product bulletin sheets. The catalog includes data on such new items as the recently introduced Palmetto Pisto-Ring packing for liquid pistons on inside-packed piston pumps. Detailed text points up application, structure and performance for each individual packing. Application charts and headline guides simplify selection.

Control Mechanism Bulletin

32 Bulletin 5450, by Hagan Corporation, Hagan Building, Pittsburgh 30, gives detailed information concerning the Hagan ratio totalizer, announced in the November issue of Petroleum Refiner. The totalizer is a pneumatically operated control mechanism for combining input control pressures and spring forces to produce a single output control pressure. Suggested applications in automatic control circuits are explained.

Gas Alarm System

33 A continuous combustible gas alarm system incorporating a new principle of gas and vapor analysis and measurement has been announced by Davis Instruments Division of Davis Emergency Equipment Company of Newark, N. J. Precision of analysis s achieved by use of a new filament construction employing fine platinum wire and thermocouple, and by measuring and recording the actual increase in temperature of the wire rather than the increased resistance as is done in the older Wheatstone Bridge principle. The system can be used as a continuous detection and alarm system for the protection of processes, plants and personnel. As a stable system, it insures constant zero balance over holidays without attention, and it functions for process control requiring a constant proportioning of combustibles in air.

Plastic Coatin

34 Technical Bulletin No. 4-10-50 containing information on the properties and methods of applying Kel-F (trifluorochloroethylene thermoplastic) dispersions has been issued by Chemical Manufacturing division of The M. W. Kellogg Company, P. O. Box 469, Jersey City 3, N. J. Kellogg has also announced that it has revised Technical Bulletins 2 and 3 which include data on the modification of Kel-F properties resulting from heat treatment and molding techniques respectively.

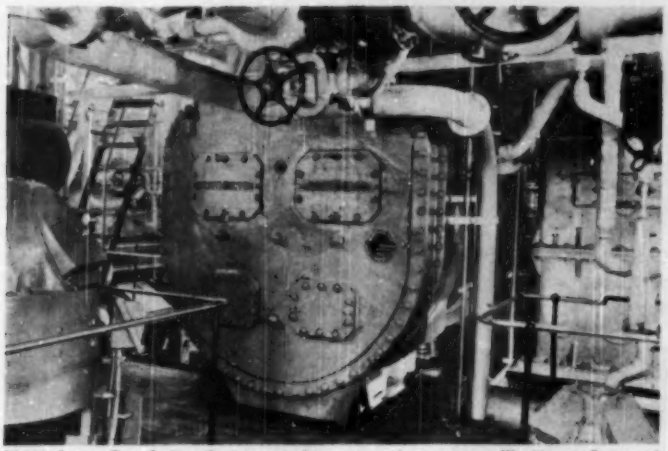
Mass Spectrometer

35 A new mass spectrometer offering ten times sensitivity and a mass range up to 400 has been

COPPER ALLOY BULLETIN

REPORTING NEWS AND TECHNICAL DEVELOPMENTS OF COPPER AND COPPER-BASE ALLOYS

Prepared by Bridgeport Brass Company "Bridgeport" *Headquarters for BRASS, BRONZE, and COPPER*



78,000 Square Feet Surface Condenser used on cargo ship . . . courtesy Worthington Pump and Machinery Corporation, Harrison, New Jersey.

Cupro Nickel Condenser Tubes Outstanding in Marine Service

Which alloy will give the best service in marine condensers? Prolonged tests under various operating conditions, made by the U. S. Navy some years ago, indicated that cupro nickel was far superior to Admiralty and generally better than aluminum brass. For this reason the Navy has, for a number of years, standardized on 70-30 cupro nickel for warships and even for other types of vessels over which it has jurisdiction.

During the war period many ships were built and were equipped with 70-30 cupro nickel condenser tubing. Examination of some of these ships show the tubes to be in fine condition even after being in operation for about ten years.

One large passenger ship built in 1940, which carried troops during the war and has been in passenger service for the past four years, has had wonderfully satisfactory service with 70-30 cupro nickel. Only a very few tubes have been plugged in the 10 years of operation. Examination of the water boxes, tube sheets and tube ends indicates that general conditions are still good.

The tubes, ¾" OD and 18 BWG gauge, are cleaned on the average of once each month. Relatively little trash finds its way into the condenser tubes themselves. When the vessel was recently in coastal areas, a school of herrings ended up in the water box which made it necessary to clean out the water boxes and condenser tubes.

Vertical impeller type pumps are used to supply circulating cooling water to the main condensers when operating at less than 10 knots. When outside harbor waters and above 10 knots, the pumps are cut out and the water is forced in through scoops protruding from the bottom of the vessel.

During cleaning, air is blown through the tubes and water boxes to dry out this area. Special protective paint is applied to the water boxes and tube sheets. When metal surfaces are new, paint adheres quite well but once under-paint corrosion occurs, it becomes more difficult to maintain the continuity of the paint film. Rust forming beneath the film causes the paint to flake off. Blocks of zinc were bolted to the water box surfaces but there was some question as to the amount of good they were doing.

Auxiliary condensers, oil coolers, refrigerating equipment and other heat exchanger units were equipped with 70-30 cupro nickel or aluminum brass tubes. Here more trouble was encountered than in the main condensers.

Examination of numerous other vessels equipped with cupro nickel condenser tubes that have been in service up to ten years also indicate that cupro nickel is giving a good account of itself.

Although Admiralty condenser tube alloy was standard for ship condensers operating in clean ocean waters for many years, the trend has been to more corrosion resisting alloys such as aluminum brass and cupro nickel. It is admitted that present day faster speeds and higher water velocities are too severe for Admiralty, which is subject to premature failure from impingement attack.

Cupro nickel often does not give a satisfactory performance in harbor waters that are brackish and polluted with wastes from cities and factories. Here aluminum brass and aluminum bronze should be tried out.

Effect of Iron Content

In recent years, iron has been added to the 70-30 cupro nickel alloy because it is beneficial in resisting impingement corrosion from clean circulating sea water.

The navy specifies iron content of 0.25-0.60% for both condenser and other types of cupro nickel tubes. When certain types of pollution contaminate the sea water, iron is not effective in retarding impingement. Cupro nickel condenser tubing is widely used in feed water heaters because it withstands the effects of higher temperatures better than the brasses.

BRIDGEPORT BRASS

BRIDGEPORT BRASS COMPANY, BRIDGEPORT 2, CONN. • *ESTABLISHED 1865*

Mills at Bridgeport, Connecticut, and Indianapolis, Indiana • In Canada: Noranda Copper and Brass Limited, Montreal

New Equipment

(For additional information or literature check item numbers on mailing coupon, page 175, or write manufacturer direct.)

announced by Consolidated Engineering Corporation, 620 North Lake Avenue, Pasadena 4, Calif. The spectrometer has a new ion source, the "Isatron," and a stainless steel analyzer which replace the previous ionization chambers, analyzer tube, and glass envelope. The resolving power, increased to extend the mass range to 400, can be adjusted during operation. Designed to eliminate alignment shifting, to minimize possibilities for electrical leakage, and to reduce or eliminate other causes of instability, the Isatron is easily demountable from the analyzer for maintenance.

Consolidated's Mass Spectrometer

Over many years of service

HAERING ORGANIC GLUCOSATES*

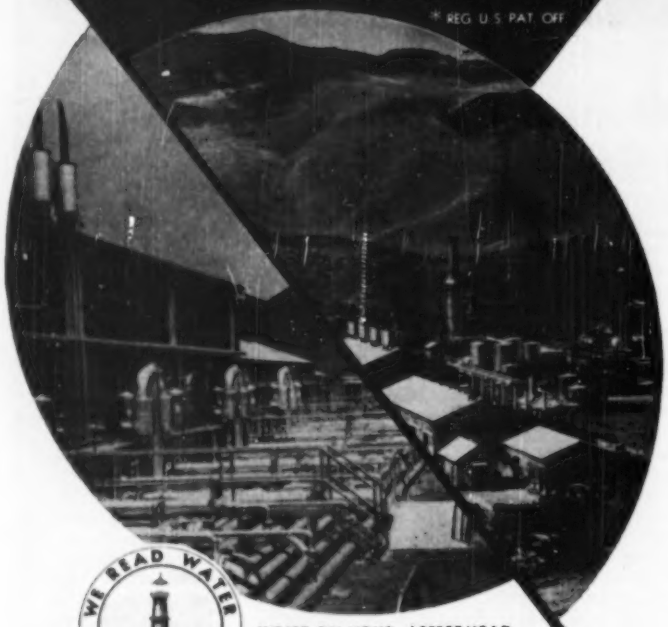
have an unexcelled record of performance in controlling

SCALE, CORROSION AND ALGAE

in the

PETROLEUM INDUSTRY

* REG U.S. PAT. OFF.



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D. W. HAERING & CO., Inc.

Established 1931

General Offices P. O. Box 6037 San Antonio, Texas

Chicago Office, 205 West Wacker Drive

Hardening Stainless Steel

36 "Methods to be Used in the Preparation of Stainless Steel for Hardening" has been published by C. U. Scott & Sons, Inc., Rock Island, Ill., to increase the uses of hardened stainless steel parts. The booklet contains suggestions for preparing the steel, describes problems that confront the metallurgist, and includes photographic illustrations of the text.

Angle "Y" Valves

37 A folder on Powell Steel "Integral Bonnet" Glove, Angle "Y" Valves has been issued by The William Powell Company, P. O. Box 106, Station B, Cincinnati 22. Included are cross sections and diagrams of the pressure seal valves, designed for services such as high pressure steam, boiler feedwater, by-pass, instrument, and throttling.

Respirator

38 An air line respirator, No. 2099, made by American Optical Company, Southbridge, Mass., is for use when paint spraying, welding, cleaning tank cars, abrasive blasting, and similar work where contaminants are heavy. Protection is against dusts, fumes, vapors, mists, smokes, and gases. Air flow is regulated by an adjustable valve clipped to the worker's belt or clothing. The respirator operates at all line pressures between 9 and 25 pounds psi.

Relief Valve

39 An off-center valve of the disc type to simplify the control of 15 psig. saturated steam with a low pressure drop has been developed by R-S Products Corporation, 4600 Germantown Avenue, Philadelphia 44. One of the valves, No. 780, is eight inches in diameter and has 150-pound American Standard raised face flanges. The cylinder is not an actuator but a dash pot. The valves are available in many sizes and for higher pressures.

Sedimentation Tanks

40 The Graver Sphericone, a sedimentation tank of new design for hot process water softeners, has been developed by Graver Water Conditioning Company, 216 West 14th Street, New York, to provide low rising rates

A Natural for
FLASHING OR
EROSIVE SERVICE
New FISHER®
Drainer Control Valve
FOR OPERATION BY PRESSURE OR
LIQUID LEVEL CONTROLLERS
Features:
• Angle body construction with renewable chrome nickel stainless steel seat ring. Directs flow directly into outlet piping. Protects body from contact with high velocity flushing fluids—preventing body washout difficulties.
• Easily dismantled for replacing worn internal parts
• Available with heavy duty or conventional positive alignment inner valve guiding.
• Iron or steel flanged angle body construction in sizes 1", 2", 3", 4" and 6".
• Operated by suitable super-structure to overcome pressure unbalance conditions.
• Furnished with Fisher Teflon V-Ring Packing. Requires no lubrication.
HEAVY-DUTY GUIDING
or
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Fisher Governor Company
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New Equipment

(For additional information or literature check item numbers on mailing coupon, page 175, or write manufacturer direct.)

and a large settling area. A hemisphere mounted on top of a cone, the inverted cone provides a uniformly increasing area from tip to circular top, while the hemisphere provides a natural strength superiority inherent in its shape. The raw water, steam and chemical inlets, spray heater, deaerator, and treated water collector are all mounted in the hemisphere, while the inverted cone contains the downtake, sludge bed, and rising zone of the water which is being treated.

Electronic Hygrometer

41 A new electronic hygrometer for measuring and controlling industrial and commercial air conditioning developed by Minneapolis-Honeywell Regulator Company, Brown Industrial Division, 4498 Wayne Avenue, Philadelphia 44, will be available in February. "The system includes a single-point electronic recorder of a circular or strip chart type, with or without control and a small element which does away with the use of human hair," said Brown engineers. "The element makes use of gold leaf and a chemical salt solution that eliminates cleaning and other maintenance." The system provides for direct relative humidity reading without assistance of psychrometric

charts. It detects changes between the limits of 20 and 93 percent relative humidity; has a minimum span of 20 percent relative humidity throughout its 20 to 93 percent range, and has available all ranges with full temperature compensation between the limits of 50 to 120 F. In the photograph, the model is holding the sensing element of the electronic control, which can register the amount of moisture a tear adds to the atmosphere.

Gas Mask Face Piece

42 A new gas mask face piece which provides chin-style, chest-style and hose-mask connections in one unit and permits full-vision is made by Acme Protection Equipment Company. The new piece, known as No. 6, is described in Bulletin No. 504 which presents sectionalized views. The mask has a new type inhalation-exhalation valve for minimum breathing resistance. The 3-in-1 feature enables use of chin canister, chest canister and hose connections on the same mask.

Address 3037 West Lake Street, Chicago, 12.

Helium Cryostat

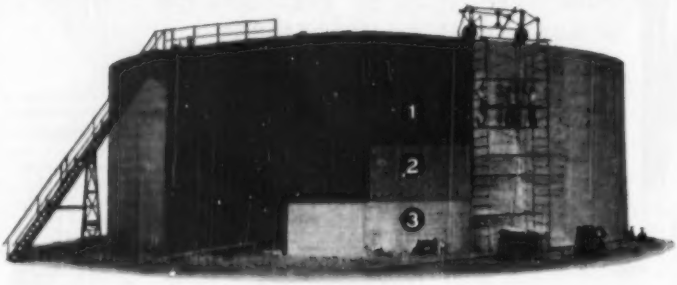
43 The Collins Helium Cryostat is described in a new folder, published by Arthur D. Little, Inc. The cryostat is used in laboratories to provide temperatures from room temperature down to a few degrees above absolute zero. Diagrams and illustrations explain the mechanics of operation.

Address Cambridge 42, Mass.

Transformer Welder

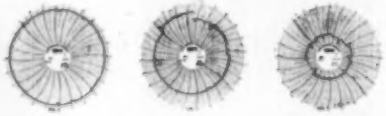
44 A 200-ampere transformer welder, Model MCX, has been developed by Air Reduction Sales Company,

NEW TANK INSULATION TECHNIQUE —NICHOLSON & GALLOWAY METHOD* AMORTIZES COST WITHIN 1 YEAR!



1. Tank metal surface is divided into areas bounded vertically by channel sections.
2. Within these areas, insulation of any type or thickness is snugly installed.
3. Insulation is then protected for the life of the tank by an outer armor. This may be .024 Corrugated Aluminum Sheathing, Asbestos Transite, Monel or Stainless Steel, etc.

Flow-Meter Charts show 80% saving in steam consumption after insulation of 300° Asphalt Tanks!



August 10:
Bare Tank 150,000 barrels
Steam Consumption:
13,500 *pounds per hour*

September 14:
Side Walls Insulated
Steam Consumption:
9,800 *pounds per hour*

December 21:
Roof Insulated
Steam Consumption:
3,300 *pounds per hour*

TANK INSULATORS · INC.

*We alone apply the Nicholson & Galloway system of Tank Insulation, Patents Pending.

TANK INSULATORS Inc., Secaucus, New Jersey
Please send me your booklet R-1 and details on cost to insulate:_____
(KIND AND SIZE OF TANK OR VESSEL)

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FIRM_____

ADDRESS_____

3-in-1 design

SLASHES FEED WATER HEATER COSTS AND SAVES PLANT SPACE

In designing and fabricating this three-stage feed water heater for a northeastern power corporation, Lummus employed an entirely new design technique. All three tube bundles are incorporated within a single shell, and, to effect further savings, the shell is bayonetted into the steam dome of the condenser.

This 28-foot feed water heater has a combined effective surface area of 4680 square feet. Each tube bundle is an individual unit separated in the shell by welded-in baffle plates.

Savings made possible by such design ingenuity are considerable. Not only does this compactness result in saving plant space, but such a compact unit costs far less to build . . . costs less to install . . . and is actually more efficient than three individual units.

A typical job? No, but a typical example of the design intelligence and construction skill that go into every Lummus-built job—advantages that are yours when you use Lummus for your heat exchanger requirements.

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Heat Exchanger Division
385 Madison Avenue, New York 17, N. Y.

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LOOK TO LUMMUS for Steam Surface Condensers • Evaporators • Feed Water Heaters • Boiler Blowdown Heat Exchangers • Steam Jet Air Ejectors • Barometric Condensers • Heat Exchangers • Process Condensers • Reboilers • Steam Generators (Indirect Fired) • Fuel Oil Heaters • Lubricating Oil Coolers • Pipe Line Coolers • Jacket Water Coolers

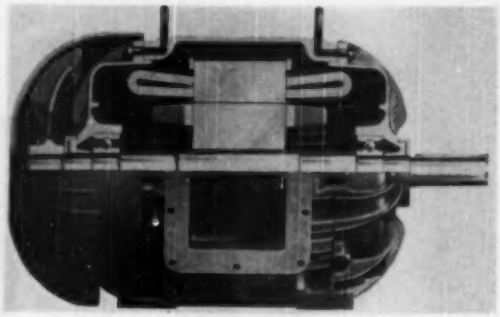
New Equipment

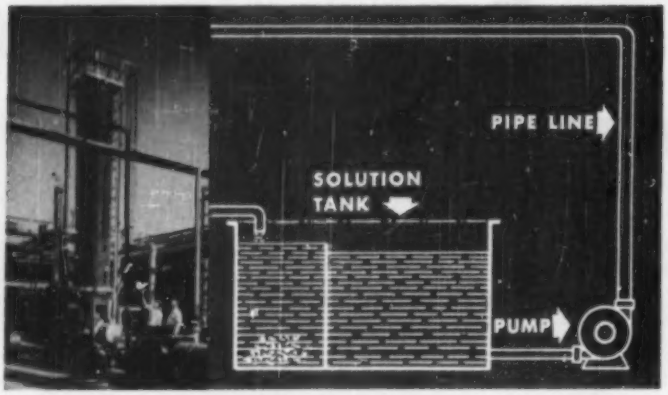
(For additional information or literature check items numbers on mailing coupon, page 175, or write manufacturer direct.)

a division of Air Reduction Company, Incorporated, 60 East 42nd Street, New York 17, to cover a wide range of applications from light duty sheet metal jobs to heavy duty industrial work. The welder has 50 percent duty cycle, NEMA rating. Three current ranges selected by insulated tapered plug connectors and infinite hand crank adjustments within each range provide currents from 30 to 250 ampere. This permits the use of 1/16 to 5/16-inch diameter electrodes. Silicone-insulated, the welder employs an automatic hot start control.

Explosion-Proof Motor

45 The Crocker-Wheeler Division of Elliott Company, Jeannette, Pa., has developed a line of explosion-proof motors, approved by Underwriters' Laboratories, for use where gases in the atmosphere make explosions a hazard. The motors, of enclosed fan cooled design, are an adaptation of the Crocker-Wheeler "Sealedpower" design. Cooling air is directed by an external fan over fins which are cast into the corrosion-resistant gray cast iron frame. The new design is available in NEMA frames 364 through 505.





How to save $1000 on Tower Cleaning

Here's the blueprint of a chemical cleaning installation that saves one refiner $1000 on his tower maintenance.

Material? Recommended Oakite detergent solution for speedy, thorough removal of grease, waxes, entrained crude—iron sulfides, chlorides, oxides.

Method? *In-place* circulation of solution. No dismantling, reaming or sawing. Cuts *days* off cleaning time.

Results? Men who use it say: "Never spent 80 bucks so happily to save $1000." "Increased output 400 gallons per hour." "Good results—even trays near top come out clean."

Details? Absolutely *free*, including blueprints. Write Oakite Products, Inc., 37 Thames St., New York 6, N. Y.

Technical Service Representatives in Principal Cities of U. S. & Canada

SPECIALIZED INDUSTRIAL CLEANING

OAKITE

TRADE MARK REG. U.S. PAT. OFF.

MATERIALS • METHODS • SERVICE

PETROLEUM SERVICE DIVISION

Porcelain Water Tank Lining

46 The availability of "Hebco" porcelain hot water tank lning through franchised distributors has been announced by How. E. Baker Company, 1499 East 4th Street, Los Angeles. Developed by engineers and ceramic chemists, this lining protects hot and cold water tanks from the effect of rust corrosion and electrolytic action. It will withstand temperatures ranging from freezing to 230° F. It is inert; it contracts and expands at the same rate as the metal used in water tanks; and it will not crack, chip or peel. The low thermal conductivity adds to the tank insulation.

Centrifugal Pump

47 Ingersoll-Rand Company, 11 Broadway, New York 4, has announced a line of new multi-stage centrifugal pumps for high-pressure applications to 1200 psi., and capacities to 1600 gpm. Known as class HMTA, they are built to 3-, 4-, 5- and 6-inch sizes with from 3 to 9 stages. Catalog Form 7233, describes the new design's cylindrical-bore, horizontally-split casing and Unit-Type rotor assembly. The rotor assembly, composed of the shaft, impellers, and channel rings, can be removed from and installed in the casing.

Corrosion-Resistant Materials

48 Munray Products, Inc., has published a new folder containing information and technical data on "Cyclon," corrosion-resistant construction materials. Among the products for the processing industries which the folder covers are industrial coatings, adhesives, process equipment linings, extrusions, chemical tubing and piping.

Address 12500 Crossburn Avenue, Cleveland 11, Ohio.

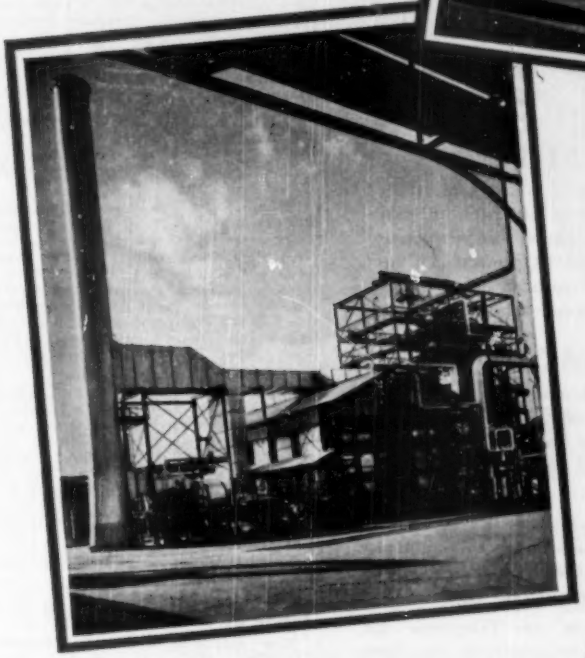
Instruments Catalog

49 A condensed catalog published by Wheelco Instruments Company, 847 West Harrison Street, Chicago 7, describes a selection of the company's indicators, controllers and combustion safeguards. A price list contains current information on most instruments manufactured by Wheelco.

These Brick Have Quick Temperature "Reflexes"

Low heat storage and conductivity! That's the reason B&W Insulating Firebrick heat or cool fast. This quick temperature reflex provides precision control in chemical and petroleum furnaces. Processes can be started — or stopped — quickly. Also important — when furnaces are shut down, there is no long delay before they can be entered for inspection.

Views of Alcorn Combustion Co. crude heater for Cántinental Oil Co., Ponca City, Oklahoma.



SAVE MONEY 3 Other Ways, Too

LOW INSTALLATION COSTS
B&W Insulating Firebrick are light, simple to install. They can be cut, drilled or shaped on the job with ordinary woodworking tools.

NO EXPENSIVE ALLOYS
These high-insulating brick can be supported by ordinary carbon steel hangers . . . don't require expensive, heat-resisting alloys.

STAYING POWER
B&W Insulating Firebrick withstand severe service for years . . . keep maintenance costs to a minimum.

See how these economies add up in your plant. Talk to your B&W Representative. He'll gladly give you facts and figures on money-saving B&W Refractories.

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B-200

BOOKS of Current Interest

Chemical Formulary

The Chemical Formulary, Volume IX, H. Bennett, Chemical Publishing Company, Inc., Brooklyn, $7.

This new volume of the Chemical Formulary series contains thousands of industrial formulae and listings of their methods of formulation. The formulas include new developments in some of the fields covered, and each is different from those in previous volumes of the series.

The formulae may be used for preparing the basic products of a manufacturing firm. They may also serve as a source of idea and a starting point of experimentation for formulating different products.

An alphabetical list of chemicals and trade mark products with the names of their manufacturers is a guide for buying the chemicals for the formulations.

NATASCO SERVICE GIVES YOU 3-WAY SAVINGS

SAVES TANKS - SAVES STEEL

Having new tanks treated by NATASCO is the sure way of getting the ultimate in use from them over a long period of years. Old tanks will also give many years additional service by receiving the proper NATASCO treatment. NATASCO protects the steel surface from all corrosion. Due to the increasing shortage of steel, and its rising cost, NATASCO service provides substantial savings.

SAVES OIL

Evaporation of volatile fractions and loss through leakage has accounted for smaller profits in many oil firms. In most cases *this loss could have been prevented if the tanks had been serviced by NATASCO.*

SAVES DOLLARS

If you have added additional years of service life to your tanks and have eliminated loss by evaporation and leakage, *you have added profits to your business.*

Every NATASCO job is Guaranteed

Wire, Write or Telephone for complete information on how NATASCO can solve your corrosion problems.

The Natasco Company

Lease Tank Service—West Texas Area: Williams Construction Company, Odessa, Texas

California Representative: Coast Contractors, Ltd., 4636 E. Slauson, Maywood, Cal.

Diesel-Fuel Survey Issued by Bureau of Mines

National Annual Diesel-Fuel Survey, 1950, O. C. Blade, Bureau of Mines, Publications Distribution Section, 4800 Forbes Street, Pittsburgh 13. Free.

In cooperation with the API, the Bureau of Mines has issued the first in a series of national annual diesel-fuel surveys. The survey is being published because of the need for more information on the types and quality of diesel fuel oils currently marketed.

Samples of the fuel, representative of actual shipments, were analyzed by the producers. Each was subjected to 14 separate tests, and the results were given to the Bureau of Mines. Fifty-six companies submitted data on 266 samples.

The data are presented in tabular form, giving the analyses in detail according to two separate arrangements.

In the first arrangement, the fuels are separated into four classes—diesel fuel oils for city buses and similar service; fuels for diesel engines in truck, tractors and similar equipment; fuels for railroad diesel engines, and heavy-distillate and residual fuels for large stationary and marine diesel engines.

In the second arrangement of tabulated data, the analyses were placed in groups according to American Society for Testing Materials grades.

Nonbenzenoid Hydrocarbons Revised by Dr. B. T. Brooks

The Chemistry of the Nonbenzenoid Hydrocarbons, Second Edition, Benjamin T. Brooks, Reinhold Publishing Corporation, 330 West Forty-second Street, New York 18. $12.

This revised edition by Dr. Benjamin T. Brooks, consulting chemist, New York, is an up-to-date survey of paraffins, olefins and cyclic (other than aromatic) hydrocarbons. It gives discussions of the chemistry, properties, methods of synthesis, thermal cracking oxidation reactions, polymerization, alkylation and theoretical aspects of the many classes of hydrocarbons having a nonbenzenoid structure.

Covered in the book are advances made in recent years—the manufacture of synthetic organic chemicals, particularly from the simpler olefins; the organic chemical raw materials from petroleum and natural gas, and the refined products made from them; the study of antiknock values of individual hydrocarbons; and the recently-developed processes of alkylation.

The first edition of the book was originally published in 1922.

Article on Grease Research

New Horizons of Grease Research, December, 1950, issue of *Lubrication* Magazine, The Texas Company, 135 East 42nd Street, New York 17. Free.

This eight-page article which appears in the current issue of *Lubrication*, a technical publication devoted to the selection and use of lubricants, gives the history of grease research and discusses some of the recent accomplishments of scientists, working with modern equipment.

Included with the article are pictures of research equipment used and electron micrographs of several grease structures.

List 581½ — (Short face to face), Rising Stem, Low Pressure, Double Disc Iron Gate Valve

List 25 — Rising Stem, Solid Wedge, Iron Gate Valve

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for Standard Gate Valves

. . . For all purposes . . . For all pressures . . . In all sizes

Be sure to check Chapman first whenever you need standard gate and check valves. Here you'll find iron valves in a complete range of sizes—both solid wedge and double disc types—for a complete range of working pressures from 25 to 800 lbs. for steam, water, oil or gas service. Operation may be by hand wheel, with or without bevel or spur gearing, floor stand, electric motor, hydraulic or pneumatic cylinder.

If, however, you need bronze valves — we have them. Just as we have a complete line of steel valves. And valves of many other types such as tilting disc, iron and steel check valves. Whenever special valves for unusual service are required, Chapman engineers will be glad to help you develop them.

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Measure and Control

Temperature
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Level
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Flow Ratio
Speed
Conductivity or pH
Per Cent Oxygen
Per Cent Combustibles
Motion or Position

with STANDARDIZED Electronic Instruments

Standardized Bailey Electronic Instrument for indicating, recording and controlling the factors listed above.

FEATURES

1. Sustained accuracy and stability insured by careful design and the use of the null balance principle.
2. Trouble free service insured by sturdy Electronic Detector which replaces moving parts and delicate instrument suspensions.
3. Comparison of related factors made easy by continuous records of as many as four factors on a single chart.
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5. Attractive control panels assured by identical styling of all recording instruments.
6. Panel space saved by installing two controllers in one instrument.
7. Choice of three controls—air, on-off electric, modulated electronic.
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Controls for Processing

TEMPERATURE FLOW
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P11

Economic-Political Factors on Oil Industry Stressed at API Meet

Frank M. Porter, reelected president of the American Petroleum Institute, told the general session at the Institute's 30th annual meeting in Los Angeles, November 13-16, that petroleum is one of the most important factors in the final determination whether this and other governments of free people will survive, or whether the totalitarian philosophy of communism will prevail.

If the petroleum industry is to fulfill its responsibilities in repelling the growing threats to our national security, API's leader said, it is essential that conditions must prevail which will assure the industry a reasonable opportunity to continue finding adequate supplies of petroleum for such purposes, in order of their paramount necessity. These conditions can only exist in an atmosphere of sympathetic understanding on the part of government and the public. Understanding of the problems of industry does not seem to exist in the minds of some members of Congress and some government officials, he declared.

Concern over the growing shortages of steel and the effect on the industry of an unhealthy political situation was the theme of most addresses heard at the meeting, the first API meeting held in Los Angeles in over a decade. Nearly 5000 oil industry people registered. For its 1951 meeting, the Institute will return to Chicago.

Oscar L. Chapman, speaking in his capacity as Petroleum Administrator for Defense, told the meeting that the oil industry will be protected against anti-trust prosecution for any collaboration undertaken as a result of formal requests from the government. A plan is being formulated, he said, to supply more steel for petroleum operations. PAD will be operated by oil men, who will impose the minimum amount of control needed to do a specific job, will disrupt the industry as little as possible, and will drop its controls and go out of business as soon as possible, he assured the group.

Chapman gave assurances that PAD will continue as a separate agency and will be his only agency to carry on oil and gas functions designated for him under the Defense Production Act.

The productive capacity of the industry, he said, must be expanded as a safeguard against an emergency and this can best be achieved by retaining the greatest degree of competition. A victory in Korea will not end the defense preparations, but the nation must prepare for an even greater emergency, he believed.

Against Stockpiling

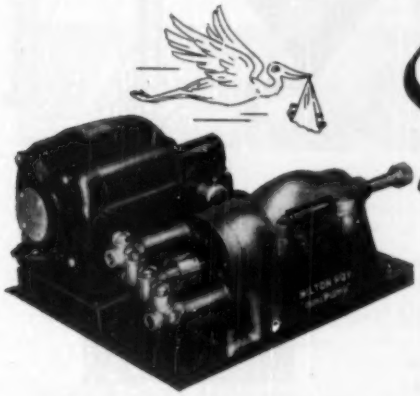
Benjamin F. Fairless, president of United States Steel Corporation, told the meeting that the industry probably will have sufficient steel for its needs for the rest of this year and 1951, if it doesn't try to stockpile. He warned, however, that a price boost was in prospect.

Other principal speakers during the meeting included, B. L. Majewski, Deep Rock Oil Corporation; H. D. Armstrong, Standard Oil Company of California; Jake L. Hamon, Mid-Continent Oil and Gas Association; R. L. Minckler, General Petroleum Corporation; Hines H. Baker, Humble Oil & Refining Company; Major-General Lewis A. Pick, chief of Army engineers; F. G. Gurley, Atchison, Topeka, and Santa Fe Railway; W. Alton Jones, Cities Service Oil Company; Reese H. Taylor, Union Oil Company of California, and Dr. Fred D. Fagg, Jr., University of Southern California.

Refining and Lubrication Divisions

The lubrication session was presided over by W. M. Murray, Deep Rock Oil Corporation, Chicago. Discussions presented included "Fuels and Lubricants Trends for Army Equipment," Colonel Benjamin S. Mesick, Chief of Research and Material Branch of the Research and Development Division of the Office of Chief of Ordnance, Washington (see page 88); "Strategic Oil Supplies," Gustav Egloff, Universal Oil Products Company, Chicago (see page 104); and "Heavy-Duty-Engine Lubricating Oils," Captain W. C. Latrobe, Director, Materials Development, Standards and Specifications Division, Bureau of Ships, Washington.

Chester F. Smith, Standard Oil Com-



Announcing the Arrival of **"miniPump"**

The Newest Milton Roy "Baby"

Mother: —the necessity for precisely metering and pumping liquids in minute quantities.

Father: —the one and only Milton Roy double ball-check design.

Weight: —42 lbs.

Capacity:—3—800 ml/hr

Pressure:—up to 1000 psi.

"miniPump" handles clear liquids in minute quantities at pressures up to 1000 psi. It is a true Controlled Volume Pump, incorporating the exclusive Milton Roy double ball-check liquid end in minified form with a fractional hp motor driver. As with all Milton Roy Pumps "mini" is a positive displacement, precise metering unit.

The liquid end is heat treated type #20 stainless steel, with stainless steel, glass or synthetic sapphire ball-checks, to handle most corrosives. Chamber displacement, or scavenging, is complete over the full range of stroke length adjustment. Capacity is readily varied while operating, from zero to maximum, by a screw and graduated scale adjustment.

"miniPumps" are available in Simplex, Duplex and Multiplex models with motor drive, also as single units powered by 1½" reciprocating air pistons.

If yours is a problem of pumping clear liquids in precisely metered volumes and very small quantities by all means investigate—see what Milton Roy's new "miniPump" can do for you.

MILTON ROY COMPANY

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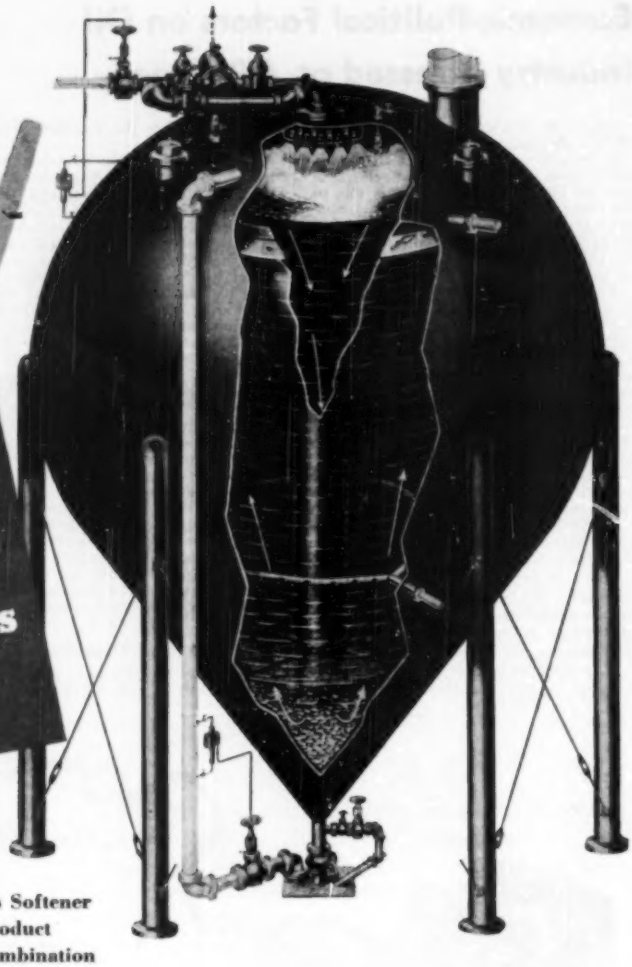
New!

GRAVER SPHERICONE for Hot Process Softening . . .



An improved design for Hot Process Softener Sedimentation Tanks . . . another product made possible by Graver's unique combination of chemical engineering skill and tank fabrication experience. • The new Graver Sphericone has many functional and structural advantages over other designs of hot process softener sedimentation tanks:

❶ *Clearest softened water* . . . because the expanding settling zone provides maximum settling area and lowest rising rates. This assures minimum load on filters . . . saves operator's time and filter media replacement.

❷ *Most efficient use of materials and space* . . . because of the exclusive Sphericone shape.

❸ *Uniform stress distribution* . . . because of the virtual elimination of knuckle radii.

GRAVER

The new Sphericone is made in Graver's own shops, together with all the other major component parts of the Graver Hot Process Softener. Write today for complete data.

GRAVER WATER CONDITIONING CO.

Division of Graver Tank & Mfg. Co., Inc.

216 WEST 14th STREET, NEW YORK 11, N. Y.

GW 431

pany (New Jersey), New York, presided over the combined session for refining and marketing, assisted by J. Howard Marshall, Ashland Oil and Refining Company, Ashland, Ky. The session heard an address by Robert E. Wilson, chairman, research committee of the board of directors of the API in presentation of API certificates of appreciation; "Synthetics in Defense," by James Boyd, Director, U. S. Bureau of Mines, Washington (see page 77); "The Reactor Program of the Atomic Energy Commission," Lawrence R. Hafstad, Atomic Energy Commission, Washington, and "Opportunities for Petroleum in the Energy Markets of the Future," by Chester F. Smith.

Other divisions of the Institute that held group sessions and committee meetings were the divisions of marketing, production, transportation, accident prevention, agricultural, financial and accounting, and public relations.

Official Slate

Five officers of the API were re-elected. W. Alton Jones, Cities Service, was reelected chairman of the board; Frank M. Porter, president; T. E. Swigart, Shell Pipe Line, vice president (transportation); B. B. Jennings, Socony-Vacuum, treasurer; and Lacey Walker, secretary and assistant treasurer. New officers elected are J. C. Donnell, II, Ohio Oil, vice president (production); W. L. Stewart, Jr., Union Oil, vice president (refining), and Harry J. Kennedy, Continental Oil, vice president (marketing).

New members of the board of directors include James J. Cosgrove, Conoco; Clyde T. Foster, Standard Oil (Ohio); Harry J. Kennedy, Conoco; J. S. Leach, Texaco; Fred M. Mayer, Continental Supply; Theodore Sutter, Baker Oil Tools; Rawleigh Warner, Pure Oil, and Clarence H. Wright, Sunray Oil.

Executive Committee

The API board of directors elected the following executive committee to serve for 1951:

K. S. Adams, Phillips; T. H. Barton, Lion Oil; Paul G. Blazer, Ashland Oil; W. R. Boyd, Jr.; H. S. M. Burns, Shell Oil; Robert H. Colley, Atlantic; J. C. Donnell, II, Ohio Oil; R. G. Follis, Standard Oil (Calif.); Clyde T. Foster, Standard Oil (Ohio); Walter S. Hallanan, Plymouth Oil; Jake L. Hamon, Mid-Cont. Oil & Gas Ass'n; Eugene Holman, Standard Oil (New Jersey); William F. Humphrey, Tide Water; A. Jacobsen, Amerada, and R. Brewster Jennings, Socony-Vacuum.

W. Alton Jones, Cities Service; Harry J. Kennedy, Conoco; John M. Lovejoy, Seaboard; L. F. McCollum, Conoco; N. C. McGowen, United Gas Pipe Line; B. L. Majewski, Deep Rock; A. C. Mattei, Honolulu Oil; J. N. Pew, Jr., Sun Oil; Frank M. Porter, API; W. S. S. Rodgers, Texaco; W. G. Skelly, Skelly Oil; P. C. Spencer, Sinclair; W. L. Stewart, Jr., Union Oil (Calif.); Sidney A. Swensrud, Gulf Oil; T. E. Swigart, Shell Pipe Line; Reese H. Taylor, Union Oil (Calif.); W. K. Warren, Warren Petroleum; L. S. Wescoat, Pure Oil, and Robert E. Wilson, Standard Oil (Indiana).

Division of Refining

The Division of Refining elected 45 members of the general committee of the division of refining for the year 1951. The new members take office January 1, 1951. The names of the new committee are:

W. R. Argyle, Sinclair; Ralph Booker, Nat'l Co-op. Ref. Ass'n; James T-B Bowles, Crown Central; George H. Burrus, Anderson-Prichard; W. J. Carthaus, Deep Rock; H. S. Chase, Tide Water; G. A. Davidson, Standard Oil (Calif.); C. E. Davis, Shell; D. E. Day, Richfield; John C. Day, WPRA; Roy J. Diwoky, Pan-Am Southern; J. H. Dunn, Shamrock; E. E. Ebner, Quaker State; H. W. Ferguson, Humble; Max M. Fisher, Aurora Gasoline; A. P. Frame, Cities Service Research & Dev.; M. Halpern, Texaco; John Hancock, Hancock Oil; H. Y. Hyde, Tide Water; W. W. Keeler, Phillips, and K. E. Kinsman, Union Oil.

J. A. LaFortune, Warren Petroleum; J. Porter Langfitt, Pure Oil; W. F. Lowe, NGAA; R. E. Luton, Ohio Oil; Maurice Machris, Wilshire Oil; P. S. Magruder, General Petroleum; F. L. Martin, Sunray; E. B. McConnell, Standard Oil (Ohio); F. W. McCurry, Derby Oil; Ray E. Miller, Du Pont; L. W. Moore, Pan-American Pet. & Transport; William Naden, Esso Standard; John W. Newton, Magnolia; Harold G. Osborn, Conoco; Max G. Paulus, Standard Oil (Indiana); J. B. Rogerson, Lion Oil; W. F. Stroud, Atlantic Refining; T. J. Sullivan, Gulf Oil; C. S. Tettsworth, Socony-Vacuum; C. H. Thayer, Sun Oil; R. L. Tollett, Cosden Petroleum; J. W. Vaiden, Skelly Oil; John S. Wertz, Vickers Petroleum, and G. E. Wynn, Mid-Continent Petroleum.

W. L. Stewart, Jr., executive vice president of Union Oil, elected vice president of refining, also serves as chairman of the general committee.

Frank M. Porter, president of API, announced the appointment of five members of the board who will serve also as members of the general committee of the division of refining. These were: Paul G. Blazer, Ashland Oil; Reid Brazell, Leonard Refineries; Glenn E. Nielson, Rocky Mountain Oil-Gas Ass'n; E. L. Shea, Ethyl Corp., and W. S. Zehrung, National Petroleum Ass'n.

Socony Chem Engineers Named Head Researchers

H. P. Caldwell has been made supervisor of the refining section of the research and development laboratories of Socony-Vacuum Oil Company, Inc. Named technical director of the development division of the labs is John W. Payne.

Caldwell has been with Socony-Vacuum since 1936.

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Asarco Lead Pipe... All commercial sizes. Special sizes on request. Chemical...Tellurium Chemical...Antimonial.

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Asarco Lead Specialties... Extrusions and Castings to specification.

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BEAVER 26-R

the only tool of its kind that . .

. . . cuts either standard "taper" or electric "straight" conduit threads by a simple adjustment.

. . . has "radio" dial size-setting. Dies can be removed in a few seconds FROM THE OUTSIDE without use of tools.

. . . is fully-adjustable and easy-working. The only 1 to 2-inch pipe threader that cuts standard, oversize and undersize threads of uniform standard length.

The Beaver 26-R uses one set of dies to thread four sizes—1, 1¼, 1½ and 2-inch. It is fully-adjustable for oversize or undersize threads to compensate for variation in fittings. There's a cam-type universal self-centering chuck, too, which centers the pipe accurately and insures straight pipe lines. Yet, "drip threads" may be cut when desired for heating lines.

Available at all leading supply houses—don't accept substitutes. Competitive in price!

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CNGA Is Reminded That Adequate Price Is Best Conservation Agent

T. L. Taggert, manager, Natural Gasoline Department, Standard Oil Company of California, in his address at the fall meeting of the California Natural Gasoline Association, stated that the purchase price commanded by natural gas is a very significant factor contributing to its conservation.

In his address, "Conservation of Natural Gas in California," Taggert pointed out that increased field prices have made it economically feasible to install facilities to conserve gas such as tank collecting systems, better collecting lines to decrease line loss, the installation of portable field compressors, dehydrators and sulfur removal equipment. Many of these, he said, are economically justified at the present price levels whereas they were not at prices paid not more than 10 years ago. As prices continue to increase, further steps in this direction can be undertaken.

"California is proud of the results obtained in the conservation of gas through cooperation of producers, gas companies, and natural gasoline manufacturers," Taggert declared. "With voluntary controls they have done as good or better than other states with mandatory controls."

The occasion was CNGA's celebration of its "25 years of service to the petroleum industry," this Silver Anniversary Fall Meeting, November 9 and 10, at Los Angeles. It was attended by some 500 members of the natural gas-gasoline industry. Departing from the usual practice of holding the meeting on one day, the association enlarged and extended the program over a period of two days by the use of special forums devoted to various phases of the industry. Particular emphasis was given to maintenance, operation, and design.

First day was devoted to five different forums running simultaneously, and the second day to the general session at the Ambassador hotel. This session was followed by the Fall Meeting Siesta held by the equipment, engineering, and supply companies at the Lido Club pool.

Forums were as follow: "The Efficient Operation and Maintenance of Plant Equipment," presided over by J. B. Taylor, Signal Oil & Gas Company, chairman; "The Application of Chemical and Process Engineering Principles to the Efficient Design and Operation of Natural Gas Processing Plants," C. D. Gard, Union Oil Company, chairman; and "The Role of the Chemist and Laboratory in Efficient Natural Gas Operation," W. W. Robinson, Jr., The Texas Company; "Progress in Gasoline Plant Equipment and Design," M. W. Kibre, General Petroleum Corporation, and L. V. Leonard, Shell Oil Company, co-chairman.

W. A. Kirk, California Southern Oil Company, served as chairman of Forum No. 5, the most unusual of the five forums, which was well attended by management personnel. The forum was entitled "The Efficient Management of Natural Gas and Natural Gasoline Operations." L. L. Purkey, manager of the Department of Organization for Standard Oil Company, was speaker at the meeting on "Organization—The Working Tools of Organization Control."

Opening address of the general session of the meeting was made by George C. McLaren, Standard Oil Company of California, and vice president of CNGA. "The CNGA Technical Committee—What We Accomplished in 1949, and Our Plans for 1950," was presented by A. C. Lyles, General Petroleum Corporation, Technical Committee Chairman.

R. W. Heath, Signal Oil & Gas Company, served as moderator for the panel discussion and recapitulation of forums held the previous day by the chairmen of those meetings. This session was titled "Attaining Over-all Efficiency in Natural Gas and Natural Gasoline Operations."

Guest speakers were James E. Pew, Sun Oil Company, president of the Natural Gasoline Association of America, and Charles S. Jones, president of Richfield Oil Corporation, and director of American Petroleum Institute.

"The Light Hydrocarbons—Their Contribution to the American Way of Life," was presented by Warren H. Kraft, Honolulu Oil Corporation. "Human Relations in the Natural Gas and Natural Gasoline Industries," by H. L. Eggleston, Analyst, and "Twenty-Five Years of CNGA—Its Service to the Industry," by R. S. Tulin, Shell Oil Company, president of CNGA.

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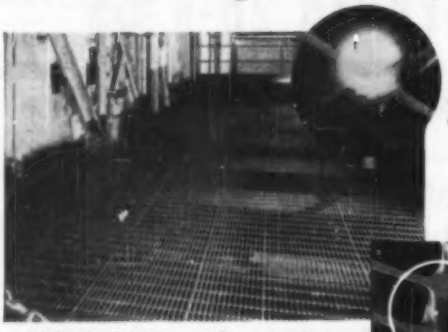

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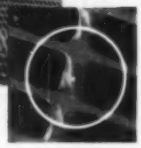

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AND NOW for a full 3000F . . . JM-3000

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By taking advantage of the quick heating characteristics of these insulating fire brick, you'll benefit through important savings in fuel because of the quicker rise to proper operating temperature in the furnace. This is a result of the low heat storage capacity and low thermal conductivity characteristics of the brick. These factors are especially important where furnaces are being intermittently operated.

The same materials can also be obtained in large size units as Johns-Manville Insulating Fireblok. This product has many advantages over the smaller size fire brick, from both a construction and stability standpoint. They can be quickly applied because they are easy to cut and fit. J-M Insulating Fireblok provide additional heat savings because they reduce the number of joints, and require less mortar for bonding.

Why not have a Johns-Manville insulation expert call to tell you more about ways in which you can save by using these insulations in your furnaces. Write Johns-Manville, Box 290, New York 16, N. Y. for further information.

	JM-1620	JM-20	JM-23	JM-26	JM-28	JM-3000
Densities, lb per cu ft	29	35	42	48	58	63-67
Transverse Strengths, psi	60	80	120	125	120	200
Cold Crushing Strengths, psi	70	115	170	190	150	400
Linear Shrinkage,† percent	0.0 at 2000 F	0.0 at 2000 F	0.3 at 2300 F	1.0 at 2600 F	4.0 at 2800 F	0.8 at 3000 F
Reversible Thermal Expansion, percent	0.5—0.6 at 2000 F	0.5—0.6 at 2000 F	0.5—0.6 at 2000 F	0.5—0.6 at 2000 F	0.5—0.6 at 2000 F	0.5—0.6 at 2000 F
Conductivity* at Mean Temperatures						
500 F	0.77	0.97	1.51	1.92	2.00	3.10
1000 F	1.02	1.23	1.91	2.22	2.50	3.30
1500 F	1.27	1.47	2.31	2.52	3.00	3.35
2000 F	—	1.73	2.70	2.83	3.50	3.60
Recommended Service						
Back up	2000 F	2000 F	2300 F	2600 F	2800 F	3000 F
Exposed	1600 F	2000 F	2300 F	2600 F	2800 F	3000 F

† *24-hr simulative service panel test for JM-3000, 24-hr soaking period for other brick.*

* *Conductivity is expressed in Btu in. per sq ft per F per hour at the designated mean temperatures.*

Note: Above tests are in accordance with A.S.T.M. tentative standards.

Johns-Manville First in INSULATIONS

About EQUIPMENT and SERVICE Suppliers

Eggelhof Engineers Expands Sales Force in New Orleans

Al Deckert, who has joined the Eggelhof Engineers organization in New Orleans, will serve as sales engineer in the Louisiana, Mississippi, and Alabama area covered by the organization east of New Orleans. Henry Turner, district manager, will devote his time to the Louisiana territory west of and including New Orleans.

Deckert

An L.S.U. graduate in mechanical engineering, Deckert served in the Army Force during World War II and has had experience as an instrument technician.

Quaker Oats Awards Contract For Chemical Plant in Omaha

Parsons Construction Company, general contractors of Omaha, has been awarded the general contract for the construction of The Quaker Oats Company's chemical plant in Omaha.

Another Omaha firm, Wray M. Scott Company, Inc., will handle all piping and plumbing work for the new plant which will produce furfural, a chemical derived from the processing of agricultural wastes.

The new plant is expected to be completed and in production by the end of 1951.

Hooker Electrochemical Names Coey Eastern Sales Manager

John S. Coey has been appointed Eastern sales manager of Hooker Electrochemical Company, Niagara Falls, New York. Thomas H. Trimble, formerly Eastern sales supervisor, will be assistant manager, Niagara sales office.

Coey, a graduate of Amherst College, has been with the Hooker company since 1937, first in charge of the Process Study group and since 1943 as manager of sales development.

Trimble, a Princeton graduate, joined Hooker in 1934 as a field salesman and was named Eastern sales supervisor in 1949.

Worthington-Gamon Meter Elects Four New Officers

New officers of Worthington-Gamon Meter Company, subsidiary of Worthington Pump and Machinery Corporation,

Wilson

Flanders

Anderson

Zeis

are Charles E. Wilson, chairman of the Board of Directors; Robert R. Anderson, president; William C. Flanders, vice president in charge of sales; Walter H.

These three Elliott Turbines are driving hot oil pumps in a new mid-west cat cracker installation. There are sixty-four in all in this plant.

ELLIOTT YR TURBINES will fit in anywhere!

- Spark-proof and totally enclosed construction
- True centerline supports
- Readily removable packing cases
- Sealed bearings
- Sealed governor
- Balanced double-seated valves
- Economical liner type bearings

■ They hold every advantage of standardization, with the tailored-to-fit qualifications of a wide range of permissible modifications available on the basic design. These modifications include speed governors, pressure governors, auxiliary controls, location of exhaust, and in fact practically every major element which could be a factor in adapting the turbine to a specific set of conditions.

Write for fully descriptive bulletin H-16.

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New, improved AIRETOOL tube rolling control brings amazing accuracy and speed to the job of condenser and heat exchanger tube expansion. A choice of four motors assures you the right power and speed. Write for literature.
The long cutting surface of this AIRETOOL expansion type cleaning head removes coke faster. The three tiers of non-tracking cutters safely remove severe deposits from still tubes. Many other cleaner types available.
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New York, Philadelphia, Chicago, Houston, Tulsa, Baton Rouge
There's an AIRETOOL Tube Cleaner and Tube Expander for every Type of Tubular Construction.

Zeis, secretary-treasurer.

Wilson has served as president of Worthington-Gamon Meter Company since 1946. In addition to his duties as chairman of the board, he will continue as vice president of the parent company where he directs the sales activities of the Vertical Turbine Pump and Construction Equipment divisions.

Anderson, newly elected president, joined Worthington-Gamon in 1922. In 1932 he was elected treasurer and in 1942, vice president.

Flanders joined the Gamon company in 1925 as sales representative in New Jersey and was appointed Worthington-Gamon sales manager in 1937.

Zeis started his career with Worthington in 1925 and served in various accounting capacities until his election as treasurer of the subsidiary company in 1948.

R. A. Fox Appointed Manager Of Graver Construction Firm

R. A. Fox has been appointed manager of Graver Construction Company for all American projects and for the company's overseas operations. The company's offices in New York, Chicago and Houston will be under his direction, as will be the supervision of an engineering division in Jersey City, N. J.

Fox

Fox, who formerly served as field assistant to E. B. Heyden, recently deceased head of the Graver Construction Company, received his mechanical engineering training in Kansas and Texas, and has had special study in thermodynamics, pneumatics and hydraulics.

First employed as engineer for Winkler Koch Engineering Company, then by Sinclair Refining Company as a designer in Houston, he later became chief engineer for plant enlargement at Derby Oil Company in Wichita and later construction engineer for new work at Shell's Wood River refinery.

For ten years he was chief engineer for the Globe Oil & Refining Company at Lemont, where he also had charge of all engineering, purchasing and construction personnel. He has served as consulting engineer, both for himself and for the Koch Engineering Company.

Devine Appointed by Wolverine

Wolverine Tube Division of Calumet and Hecla Consolidated Copper Company, Inc., has appointed Buel A. Devine as commodity sales manager. Devine will be in charge of tube sales to wholesalers and jobbers.

Kerotest to Produce Valve Developed by General Valve

Manufacturing rights have been acquired by Kerotest Manufacturing Company, Pittsburgh, to produce a new type of plug valve which has been under development and production by General Valve Service Company, Long Beach, Calif.

The valve is a non-lubricated plug valve designed for operation at normal to sub-zero temperatures and for a

If you're all "gummed up"

in a tough heat transfer problem

Specify..

Vogt Spiral, Spring Type Scraper
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CHILLERS

Photos show shop assembly without driving motor.

Fouling of the inner pipe surfaces of Vogt Chillers is eliminated, because they are swept clean continuously during operation by patented spiral, spring type scrapers. And these clean surfaces achieve the highest possible rate of heat transfer between the solution and the refrigerant.

VOGT DOUBLE PIPE TYPE CHILLERS are designed to use ammonia, brine, or cold dewaxed oil as the cooling medium. Oil or brine, when employed, is circulated through the jacket pipes countercurrent to the flow of the solution in the inner pipes.

MULTI-PIPE TYPE CHILLERS, for direct expansion, have large jacket shells each containing seven inner pipe sections and employ volatile refrigerants such as ammonia, freon, propane, etc.

Our engineering staff is qualified by training and experience to help you find the right answers to your heat transfer problems. Their recommendations are available without obligation.

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vapor-tight shut off in all types of gaseous and volatile liquid service, according to Stanley J. Roush, president of Kerotest. It will be marketed under the trade name, Kerotest General Twin Seal Valve. It has in the past been marketed by General Valve Service Company in California and the Mid-Continent.

Edward Valve Appoints Sales Representative for Europe

Societe Audco Belge S. A., Brussels, Belgium, has been appointed sales representative in continental Europe for Edward Valves, Inc., East Chicago, Ind. Sales contacts will be under the supervision of Fred O. Spitzer, who will travel Belgium, Denmark, France, Holland, Italy, Luxembourg and Switzerland.

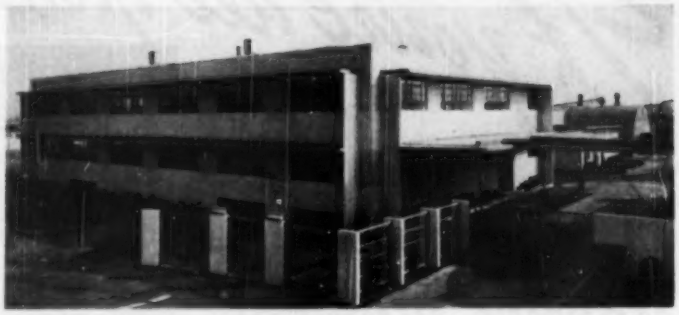
Societe Audco Belge is a subsidiary of Audley Engineering Company, Ltd., Newport, Shropshire, England, which is licensed to build and market Nordstrom lubricated plug valves in the British Isles and on the Continent.

Universal Oil Products Ups Price of Gasoline Inhibitors

Universal Oil Products Company has increased the price of their butyl amino phenol and para phenylene diamine gasoline inhibitors, marketed as UOP Nos. 4 and 5. UOP No. 4 was upped four cents per pound, while No. 5 was raised 7½ cents per pound.

The company has announced that while inhibitor supplies appear adequate, the critical supply of steel has necessitated that deliveries be handled on a returnable container basis.

Fluor Occupies New Building



FLUOR ENGINEERING BUILDING—A new $400,000 engineering building located at the main plant, 2500 South Atlantic Boulevard, Los Angeles, was dedicated in October during the 60th anniversary celebration of The Fluor Corporation. Construction is of precast reinforced concrete and walls were raised with the newest tilt-up methods. The building is air conditioned throughout and contains 27,000 square feet of floor space, providing facilities for 150 draftsmen and 25 project engineers on the two main floors.

Keck Elected Vice President Of Borg-Warner Corporation

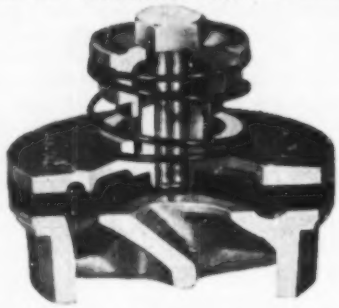
Mathew Keck has been elected a vice president of Borg-Warner Corporation. He also will continue in his post as treasurer.

Keck joined the Borg & Beck Company in Moline, Ill., in 1920 as controller, then became secretary-treasurer. He was named secretary-treasurer of Borg-Warner when the corporation was formed in 1928, with Borg & Beck as one of the four original founding companies. He retained that post until last April, when he became treasurer and Ray W. Dose was named secretary.

Oakite Products Conducts Technical Sales Meetings

How recent developments in the field of cleaning and allied procedures are helping industry meet the demands of increased production was the central theme of a series of technical-sales meet-

SIMS INCLINED PORT ROTATING PUMP VALVES



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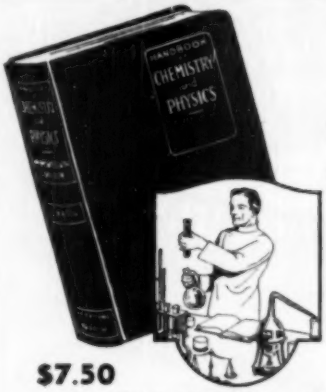

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. . . single-layer application saves money

When you can insulate a pipe efficiently with only one layer of covering, you save money. The range of thicknesses in which Unibestos Pipe Insulations are made permits the economies of single-layer application. Also a distinct saving in warehousing is made possible because fewer sizes of insulation are required in stock for maintenance work. But range of insulation thicknesses for single-layer application is only one of the many features of these 2 great pipe insulations—UNIBESTOS No. 750 and No. 1200. Write today for catalog giving complete information.*

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**New 8-page catalog (No. 48-1023) "UNARCO Insulations • Asbestos Packings • Gaskets • Textiles"*

ings held in New York, Cleveland, and Hollywood, Calif., during November by Oakite Products, Inc.

The first of these conferences in New York was attended by field service representatives of the company's New York, New England, Southern and Canadian sales divisions. Similar conferences held in Cleveland and Hollywood, were attended by Oakite technical service representatives from the Chicago, Cleveland, Detroit, Milwaukee and Philadelphia divisions and the Pacific Coast, Midwestern and Southwestern sales territories respectively.

Pittsburgh Coke & Chemical Transfers Lawlor to Tulsa

E. W. (Red) Lawlor, sales-service representative of Pittsburgh Coke & Chemical Company, has been transferred from the Pittsburgh home office to the Tulsa office of the company's Protective Coatings division. In his new location, Lawlor will assist Frank McNulty, Tulsa manager, in serving the corrosion-protection needs of the central west.

Lawlor

Lawlor has been with the coal tar products industry almost exclusively since his graduation from Pratt Institute in 1941. Employed by Pittsburgh Coke & Chemical Company first as supervisor of the early protective coatings plant, he later moved into sales-service.

G. E. Names Three to Posts Of Reorganized Divisions

J. T. Farrell has been named assistant to the manager of sales of General Electric's Small and Medium Motor divisions. In addition to specific assignments, he will supervise the Marketing and Promotion division and a newly-created Gear-Motor and Package Drive Sales division.

Howard W. Bennett was appointed manager of the Gear-Motor and Packaged Drive Sales division, and Paul D. Ross was named manager of another new group, the Erie, Pa., D-C Armored Motor Sales division.

The former Gear-Motor Sales division and D-C Motor Sales division have been dissolved. Products of the discontinued division that are not assigned to either of the two new divisions will be transferred to the Lynn, Mass., Motor Sales division.

Dr. H. K. Ihrig Elected Head Of Allis-Chalmers Research

Dr. H. K. Ihrig has been elected vice president in charge of research of Allis-Chalmers Manufacturing Company, Milwaukee. Dr. Ihrig resigned as vice president and director of laboratories of Globe Steel Tubes Company, with whom he had been associated for the past 17 years.

Dr. Ihrig was cited in 1949 by the University of Wisconsin college of engineering for his contributions and inventions, particularly in the field of metallurgy. In 1947 he was awarded the Robert W. Hunt medal by the AIME for the best paper published on iron and steel research.

Dr. Ihrig attended Carleton College and the University of North Dakota, receiving a B.S. degree from the latter in 1919, and master of science degree in 1920. He received his Ph.D. from the University of California in 1923.

Dr. Ihrig, who holds 19 patents, has served during the past two years as a consultant for Allis-Chalmers in connection with the company's participation in the work of the Atomic Energy Commission.

Cochrane Names Sales Manager

Cochrane Corporation, Philadelphia, manufacturer of water conditioning apparatus and steam power plant specialties, has appointed Ervin J. Bookout general sales manager. Bookout has been Cochrane's Eastern sales manager, and before that for many years a sales engineer in the Philadelphia territory.

Bookout

National Supply Names Head Of Washington, D. C., Branch

Ralph S. Lorimer will be branch manager of The National Supply Company's new Washington, D. C., office. He has a background in diesel engineering which dates back to 1917, when he joined the Atlas Imperial Diesel Engine Company of which his father was one of the founders. He has been engaged in almost every phase of diesel engine

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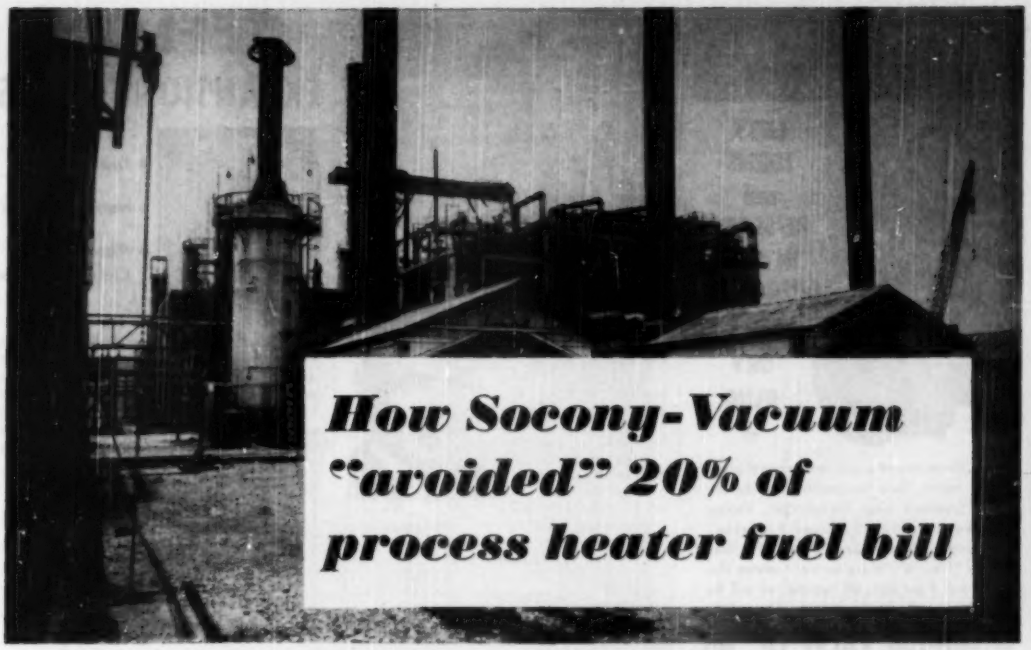

How Socony-Vacuum "avoided" 20% of process heater fuel bill

program →

When engineers at Socony-Vacuum, Trenton, Michigan refinery developed a complete fuel conservation program, process heaters came under close scrutiny. Socony-Vacuum engineers felt they could reduce the total cost of fuel used in raising the temperature of petroleum stock if they could keep the amount of excess air in the flue gases at a minimum.

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must provide a **continuous indication** so that changes could be spotted immediately.

must **not be affected by changes in fuel composition** since different fuels are used in the heater furnaces.

must not **be affected by the presence of Hydrogen** in the gas sample.

preferably, measurement should have **direct relationship to excess air.**

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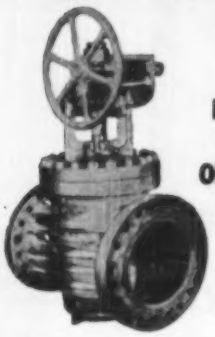

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manufacturing, and before joining National Supply was in charge of the Lorimer Diesel Engine Company of the Atlas Imperial organization.

A veteran of both World Wars, Lorimer served during World War II in the Navy for five years, completing his tour of duty in 1946 with the rank of commander.

Byron Jackson Company Names Los Angeles Branch Manager

C. O. Relephord has been appointed Los Angeles branch manager for the Fuels division, Byron Jackson Company, with territory covering several western states, Mexico and the Far East.

Relephord

Relephord was graduated from the University of Oklahoma in 1932 with a bachelor of science degree in petroleum engineering, refinery option. He then was employed in a sales engineering capacity.

After serving during World War II with the U. S. Pacific Fleet, in 1946 Relephord joined Byron Jackson Company in the Houston office, where he has been active in the analysis of the technical applications of pumps for the oil industry.

S. Morgan Smith Company Buys R-S Products of Philadelphia

The R-S Products Corporation, Philadelphia, has been purchased by S. Morgan Smith Company of York, Pa., hydraulic turbine and valve manufacturer.

Although terms of the purchase were not disclosed, the Philadelphia company reported that its annual sales have been substantially in excess of a million dollars. R-S Products currently has on its books an unfilled backlog of orders exceeding $1.25 million.

Beauchamp E. Smith, president of S. Morgan Smith Company, announced that the present management of R-S Products, W. E. Borbonus, president, and D. W. Hopkins, executive vice president, will be retained along with the present five-man board of directors.

The Smith Company will provide two additional members of the board, Burwell B. Smith, vice president, and Duncan D. McArthur, secretary of the parent company. There will be no change in the operation of the Philadelphia concern.

Pyrene Executive Dies While In Los Angeles for API Meet

Charles G. Durfee, vice president and member of the board of directors, Pyrene Manufacturing Company, Newark, N. J., died November 13 at Los Angeles, where he was attending the annual meeting of the API.

Durfee joined the company in 1928 as a sales engineer, becoming manager of the Systems department in 1930. From 1938-1945 he served as assistant to the vice president in charge of sales. He was elected to the board of directors in 1944 and in 1945 was made director of fire protection engineering. In 1948 he was elected vice president in

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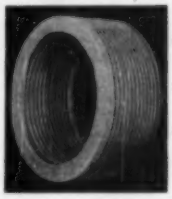

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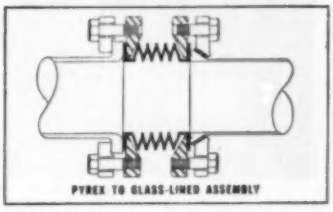
If your problem is thermal expansion, vibration, misalignment or any other condition demanding a flexible, chemical-proof piping section, then USG's Chemiseal Teflon Expansion Joints can save you money. They're tough, long-lasting and completely impervious to chemical attack.



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Chemiseal Teflon Expansion Joints are available for any type of equipment and for a wide variety of operating conditions. Joints are normally supplied with suitable integrally-gasketed flanges drilled to 150 lb. A.S.M.E. standard. Exact requirements must be specified, so we'll be glad to send you Catalog No. 212 containing complete information.

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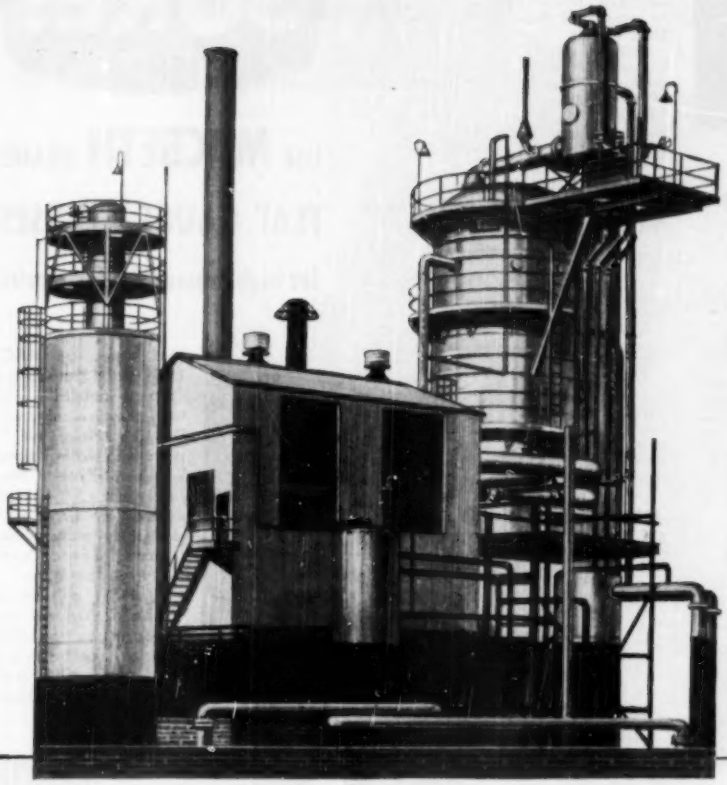

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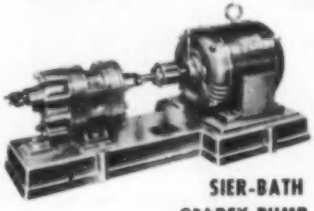

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Two general types: **INTERNAL BEARING TYPE** (above) for lubricating liquids, **EXTERNAL BEARING TYPE** for non-lubricating liquids. Capacities: 1-550 GPM. Discharge: 250 PSI for viscous liquids, 50 PSI for water. **SIER-BATH SCREW PUMPS** for higher pressures and capacities.

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charge of engineering. He was also president and director of Chemical Concentrates Corporation, Fort Washington, Pa., a Pyrene subsidiary.

Graduating from Sheffield Scientific School, Yale University, in 1918 with a Ph.B. degree and in 1920 from the Yale Graduate School with an M.E. degree, he joined the New York Edison Company in New York City as combustion engineer. From 1921 to 1925 he did market analysis work for the sales department of Westinghouse Electric and Manufacturing Company in New York City and San Francisco. This was followed by two years with the Society for Electrical Development, Inc., in New York.

C. H. Woolley, Design Engineer For Babcock & Wilcox, Dies

Charles Henry Woolley, 44, assistant manager of the Proposition department of The Babcock & Wilcox Company, New York, died November 11 in Cranford, N. J.

Woolley was the inventor of many improvements in steam generator construction and operation, which are the subject of patents and pending applications of The Babcock & Wilcox Company. His career with that company began as an apprentice engineer in 1927 upon his graduation from Purdue University with a mechanical engineering degree.

J. W. Geisler Joins Staff Of Fisher Scientific Company

J. William Geisler has joined the Pittsburgh staff of Fisher Scientific Company as petroleum apparatus engineer. Geisler, who has had 13 years experience in the petroleum field, will advise on related matters of engineering, manufacture and distribution of the company's Tagliabue line of petroleum testing equipment.

Geisler

Formerly he was with the Bureau of Mines, Bruceton, Pa., where he did research and development on synthetic and liquid fuels. Prior to this he was with the Army Ordnance Department, Gulf Oil Corporation, and Duquesne Light Company of Pittsburgh. He is a graduate of Adrian College, Adrian, Mich., and attended Carnegie Institute of Technology.

Manning, Maxwell & Moore Names Valve Sales Manager

R. F. Attner has been appointed manager of valve distributor sales of Manning, Maxwell & Moore, Inc.

Serving since 1945 as assistant sales manager for Hancock Valves at Watertown, Mass., Attner joined the company in 1922 as an inventory clerk, later moving into a production department. In 1929, he was made assistant office manager in Boston, and in 1937, chief sales correspondent for Hancock Valves.

Carpenter Steel Names Staples

William R. Staples, formerly West Coast representative, has been appointed assistant to the manager of sales, Alloy

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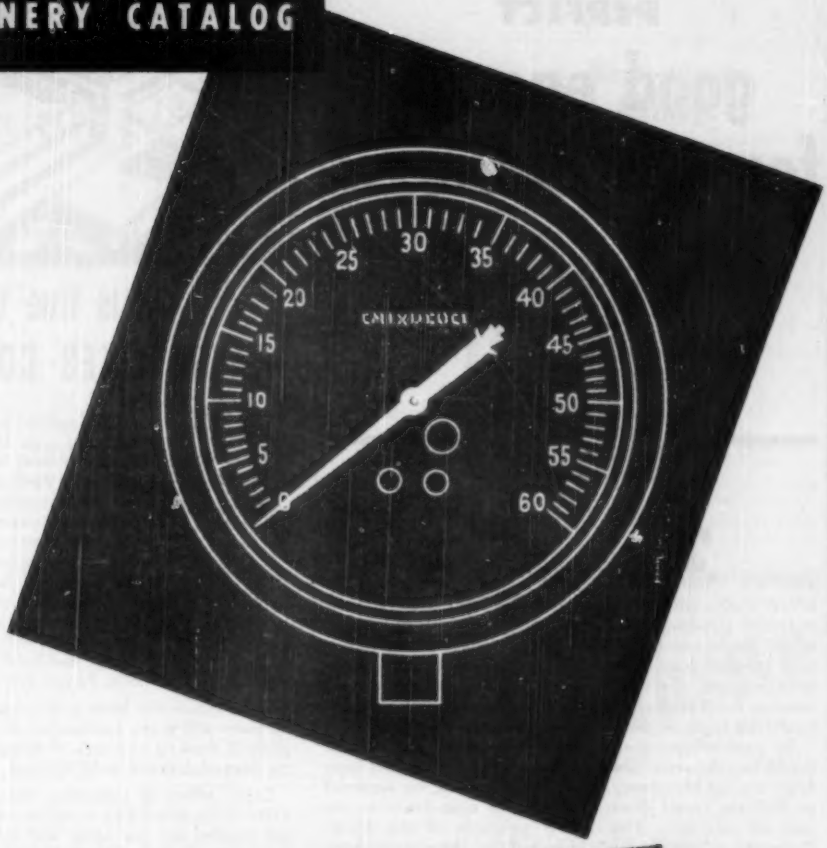
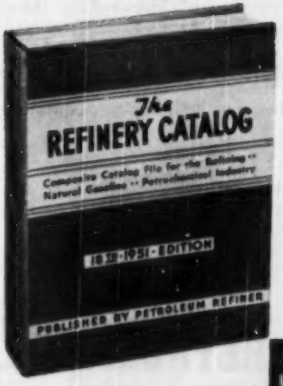


Complete catalog information when you need it

Reach for your copy of Refinery Catalog whenever you specify gauges or any other process plant equipment. Turn to the easy-to-use index and you'll find that most, if not all, of the known manufacturers of the product you have in mind have their catalogs filed in this handy volume. The new Refinery Catalog carries catalog information on refinery, natural gasoline and petrochemical plant equipment made by 330 companies. No wonder RC is the preferred source of catalog information among refinerymen the world over.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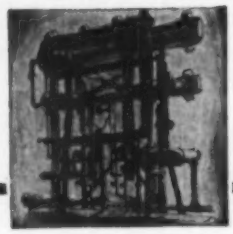

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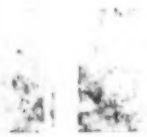

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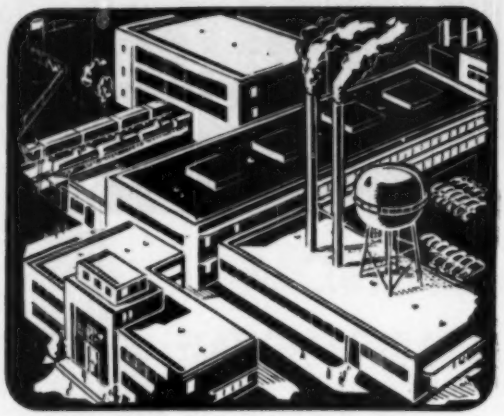

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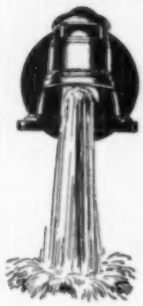

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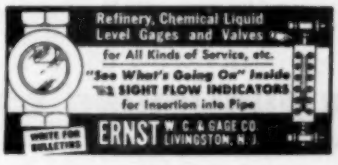
Tube division of The Carpenter Steel Company, Union, N. J. Paul E. Kelly will take over West Coast duties formerly handled by Staples.

British Company Will Make Lummus Heat Exchangers

Whessoe Limited, by agreement with Lummus Company of New York, will manufacture heat exchangers conforming to Lummus design and thermal ratings at Darlington, England. The English company has already built many Lummus heat exchangers under previous arrangements.

Laclede-Christy Moves Office

Laclede-Christy Company has moved its executive, fiscal, and operations offices to 310 South Michigan Avenue, Chicago 4. The general sales office is in Pittsburgh in the Iriquois Building.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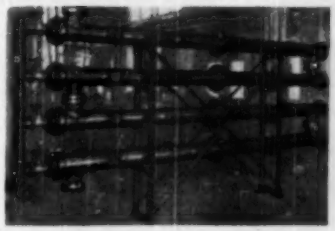

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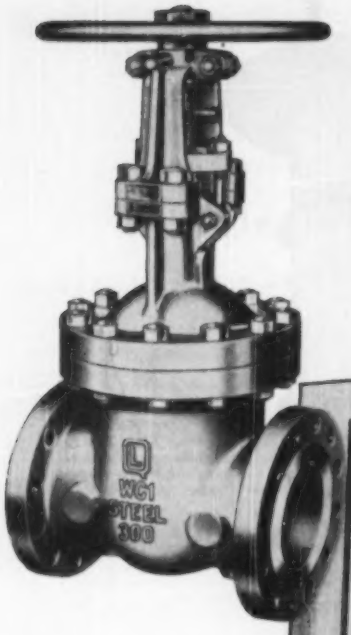

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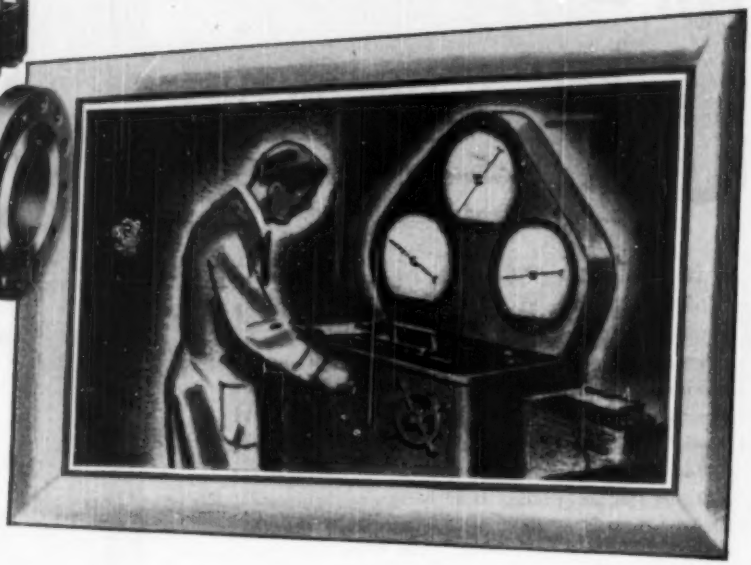

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